PB-215 396

REPORT FOR CONSULTATION ON THE METROPOLITAN KANSAS CITY INTERSTATE AIR QUALITY CONTROL REGION

National Air Pollution Control Administration
Washington, D. C.

March 1969

DISTRIBUTED BY:

NTIS

National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

PB 215 396
12324

REPORT FOR CONSULTATION ON THE METROPOLITAN KANSAS CITY INTERSTATE AIR QUALITY CONTROL REGION

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Consumer Protection and Environmental Health Service
National Air Pollution Control Administration

NATIONAL TECHNICAL
INFORMATION SERVICE

BIBLIOGRAPHIC DATA SHEET	1. Report No. APTD-1223	2.	3. Recipient's Accession No.

4. Title and Subtitle
Report for Consultation on the Metropolitan Kansas City Interstate Air Quality Control Region

5. Report Date
March 1969

6.

7. Author(s)

8. Performing Organization Rept. No.

9. Performing Organization Name and Address
U. S. Department of Health, Education, and Welfare
Public Health Service
Consumer Protection and Environmental Health Service
National Air Pollution Control Administration

10. Project/Task/Work Unit No.

11. Contract/Grant No.

12. Sponsoring Organization Name and Address
Same

13. Type of Report & Period Covered

14.

15. Supplementary Notes

16. Abstracts

The basic background information is presented for the consultation with state and local authorities prior to the designation of air quality control regions as stipulated in the Clean Air Act. Boundaries for the regions are proposed and the factors which are the basis for the proposed boundaries are discussed. Reports for consultation consider these factors: geography; population and economic activity; their prospective growth; probable direction of physical growth; the emission inventory and the location of sources; air quality and pollution transport analysis; regional planning; air pollution control; and governmental jurisdictions.

17. Key Words and Document Analysis. 17a. Descriptors

Air pollution
Regions
Geography
Humans
Industrial plants
Trends
Exhaust emissions
Inventories
Environmental surveys
Atmospheric diffusion
Planning
Abatement
Government

17b. Identifiers/Open-Ended Terms

17c. COSATI Field/Group 13B

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Unlimited	UNCLASSIFIED	52 51
	20. Security Class (This Page) UNCLASSIFIED	22. Price 4.75

FORM NTIS-35 (10-70) USCOMM-DC 40329-P71

The Clean Air Act requires the designation of 'air quality control regions' prior to the adoptation of air quality standards and plans for implementation of the standards. A study was thus conducted of the Metropolitan Kansas City area.

The results of the study are presented in the report. It consists of a description of the region, an emission inventory, meteorology, and urban factors.

REPORT FOR CONSULTATION ON THE

METROPOLITAN KANSAS CITY INTERSTATE

AIR QUALITY CONTROL REGION

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Consumer Protection and Environmental Health Service
National Air Pollution Control Administration
March, 1969

2

CONTENTS

PREFACE..... 3

INTRODUCTION..... 5

EVALUATION OF ENGINEERING FACTORS..... 13

EVALUATION OF URBAN FACTORS..... 31

THE PROPOSED REGION..... 44

DISCUSSION OF PROPOSAL..... 44

PREFACE

The Secretary, Department of Health, Education, and Welfare, is directed by the Air Quality Act of 1967 to designate "air quality control regions" to provide a basis for the establishment of air quality standards and the implementation of air quality control programs. In addition to listing the major factors to be considered in the development of region boundaries, the Act stipulates that the designation of a region shall be preceded by consultation with appropriate State and local authorities.

The National Air Pollution Control Administration, DHEW, has conducted a study of the greater Kansas City area, the results of which are presented in this report. The Region* boundaries proposed in this report reflect consideration of available and pertinent data; however, the boundaries remain subject to revision suggested by consultation with State and local authorities. Formal designation will be withheld pending the outcome of the meeting. This report is intended to serve as the starting point for the consultation.

The Administration is appreciative of assistance received either directly during the course of this study or indirectly during previous studies from the official air pollution agencies of the affected states and counties, the Metropolitan Planning Commission (Kansas City Region), the Chamber of Commerce of Greater Kansas City, the Missouri State

*For the purposes of this report, the word region, when capitalized, will refer to the Metropolitan Kansas City Interstate Air Quality Control Region. When not capitalized, unless otherwise noted, it will refer to air quality control regions in general.

Highway Commission, the State of Kansas Department of Economic Development, the Topeka-Shawnee County Metropolitan Planning Agencies, and the State of Missouri Department of Community Affairs.

INTRODUCTION

> "For the purpose of establishing ambient air quality standards pursuant to section 108, and for administrative and other purposes, the Secretary, after consultation with appropriate State and local authorities, shall, to the extent feasible, within 18 months after the date of enactment of the Air Quality Act of 1967 designate air quality control regions based on jurisdictional boundaries, urban-industrial concentrations, and other factors including implementation of air quality standards. The Secretary may from time to time thereafter, as he determines necessary to protect the public health and welfare and after consultation with appropriate State and local authorities, revise the designation of such regions and designate additional air quality control regions. The Secretary shall immediately notify the Governor or Governors of the affected State or States of such designation."
>
> Section 107(a), Air Quality Act of 1967

Air pollution, because of its direct relationship to people and their activities, is an urban problem. Urban sprawls often cover thousands of square miles; they quite often include parts of more than one state and almost always are made up of several counties and an even greater number of cities. Air pollution, therefore, also becomes a regional problem, and the collaboration of several governmental jurisdictions is prerequisite to the solution of the problem in any given area. Air quality control regions called for in the above-quoted section of the Air Quality Act of 1967 are meant to define the geographical extent of air pollution problems in different urban areas and the combination of jurisdictions that must contribute to the solution in each.

The regional approach set up by the Air Quality Act is illustrated

in Figure 1. The approach involves a series of steps to be taken by Federal, State, and local governments, beginning with the designation of regions, the publication of air quality criteria, and the publication of information on available control techniques by the Federal Government. Following the completion of these three steps, the Governors of the States affected by a region must file with the Secretary within 90 days a letter of intent, indicating that the States will adopt within 180 days plans for the implementation, maintenance, and enforcement of those standards in the designated air quality control regions.

The new Federal legislation provides for a regional attack on air pollution and, at the same time, allows latitude in the form which regional efforts may take. While the Secretary reserves approval authority, the States involved in a designated region assume the responsibility for developing standards and an implementation plan which includes administrative procedures for abatement and control.

The basic objectives in the designation of an air quality control region is that it be self-contained, i.e. that the transfer of air pollution out of or into a region is minimized. This objective recognizes the fact that an air quality control region cannot be delineated in a way to make it completely independent with respect to the air pollution problem. Because air pollutants can be carried long distances, the air over a region can be subjected occasionally or even frequently to trace amounts of pollution from other cities and individual sources located outside its boundaries. Under specific and episodic conditions such contributions can even reach significant quantities. The problem of a boundary designation

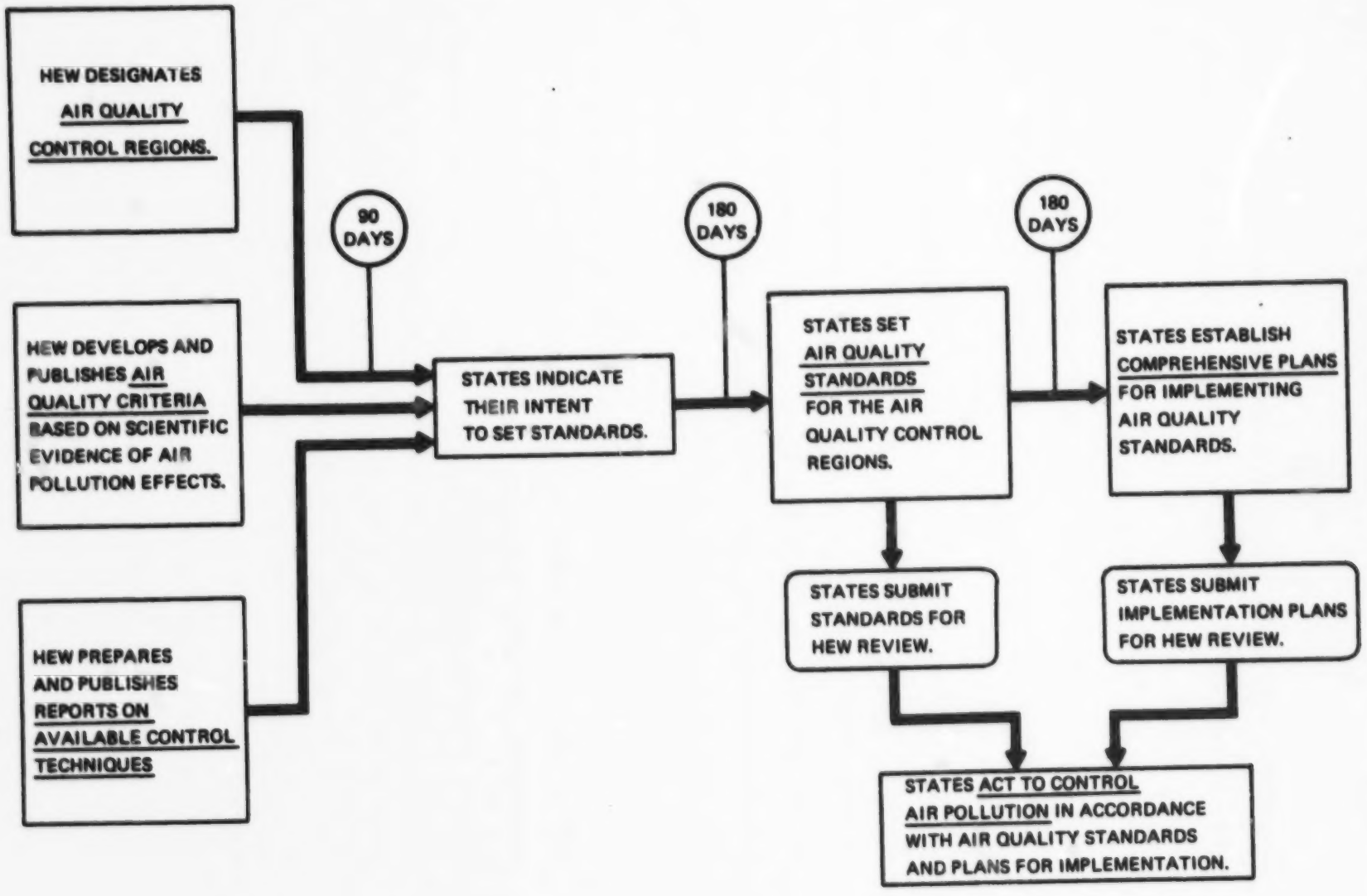

HEW DESIGNATES AIR QUALITY CONTROL REGIONS.
HEW DEVELOPS AND PUBLISHES AIR QUALITY CRITERIA BASED ON SCIENTIFIC EVIDENCE OF AIR POLLUTION EFFECTS.
HEW PREPARES AND PUBLISHES REPORTS ON AVAILABLE CONTROL TECHNIQUES
90 DAYS
STATES INDICATE THEIR INTENT TO SET STANDARDS.
180 DAYS
STATES SET AIR QUALITY STANDARDS FOR THE AIR QUALITY CONTROL REGIONS.
180 DAYS
STATES ESTABLISH COMPREHENSIVE PLANS FOR IMPLEMENTING AIR QUALITY STANDARDS.
STATES SUBMIT STANDARDS FOR HEW REVIEW.
STATES SUBMIT IMPLEMENTATION PLANS FOR HEW REVIEW.
STATES ACT TO CONTROL AIR POLLUTION IN ACCORDANCE WITH AIR QUALITY STANDARDS AND PLANS FOR IMPLEMENTATION.

FIGURE 1. FLOW DIAGRAM FOR ACTION TO CONTROL AIR POLLUTION ON A REGIONAL BASIS, UNDER THE AIR QUALITY ACT.

is further compounded in that urban areas generally do not end abruptly but are surrounded by activities that can contribute to the pollution of the urban area as well as be the recipients of its generated pollution. Consideration of all these possibilities would result in regions substantially larger than is practical or even necessary to get to the brunt of the problem. The primary question, therefore, becomes one of relative magnitude and frequency.

The boundaries of regions, however, should encompass areas that contain sources that add significantly to the pollution load of the air as well as the areas that are significantly and continuously affected by it. For this purpose, the delineation of regional boundaries is based on evaluation of annual and seasonal air pollutant emissions and resultant ambient concentrations rather than those based on short-term and specific conditions.

The selection of regional boundaries should not be based solely on today's conditions and needs, but, perhaps more importantly, should give consideration to future development and growth of the area. For this purpose, extensive consideration should be given to prescribed metropolitan plans as well as the forecasted growth. Such considerations should result in the designation of regions that will contain the sources and receptors of regional air pollution for a number of years to come. This is not to say that the regional boundaries should remain stationary and unchanged. Periodic review of boundaries is desirable, and changes in the boundary should be considered if conditions warrant.

The delineation of region boundaries solely on the basis of source

locations and distributional patterns of ambient air pollution would most likely result in regions that do not follow any existing governmental boundaries, are difficult to define, and, more importantly, extremely difficult if not impossible to administrate. It is for this purpose that existing jurisdictional entities are reviewed and wherein practical the boundary lines of a region should include that combination of whole jurisdictions that encompasses the problem area. There can be exceptions to that philosophy, however. The presence of overly large jurisdictions, marked topographical features (mountains), or notable differences in development within a given jurisdiction may, in some cases, make it desirable to include only portions of some jurisdictions.

A region, then, will represent a balance between the various objectives discussed so far to the extent that any two of them lead to different conclusions. The strength of some factors over others may lead to region boundaries which exclude some sources of pollution that might affect the air quality or part or all of the nearby region under certain conditions. Even though the impact of such sources would probably be minimal, the implementation plan required under the Air Quality Act for the region should provide a mechanism for the control of point sources that are located just beyond the region boundary. Such a provision would be consistent with the basic objective of providing desirable air quality within an area being designated as an air quality control region.

Figure 2 summarizes the procedure used by the National Air Pollution Control Administration for designating air quality control regions.

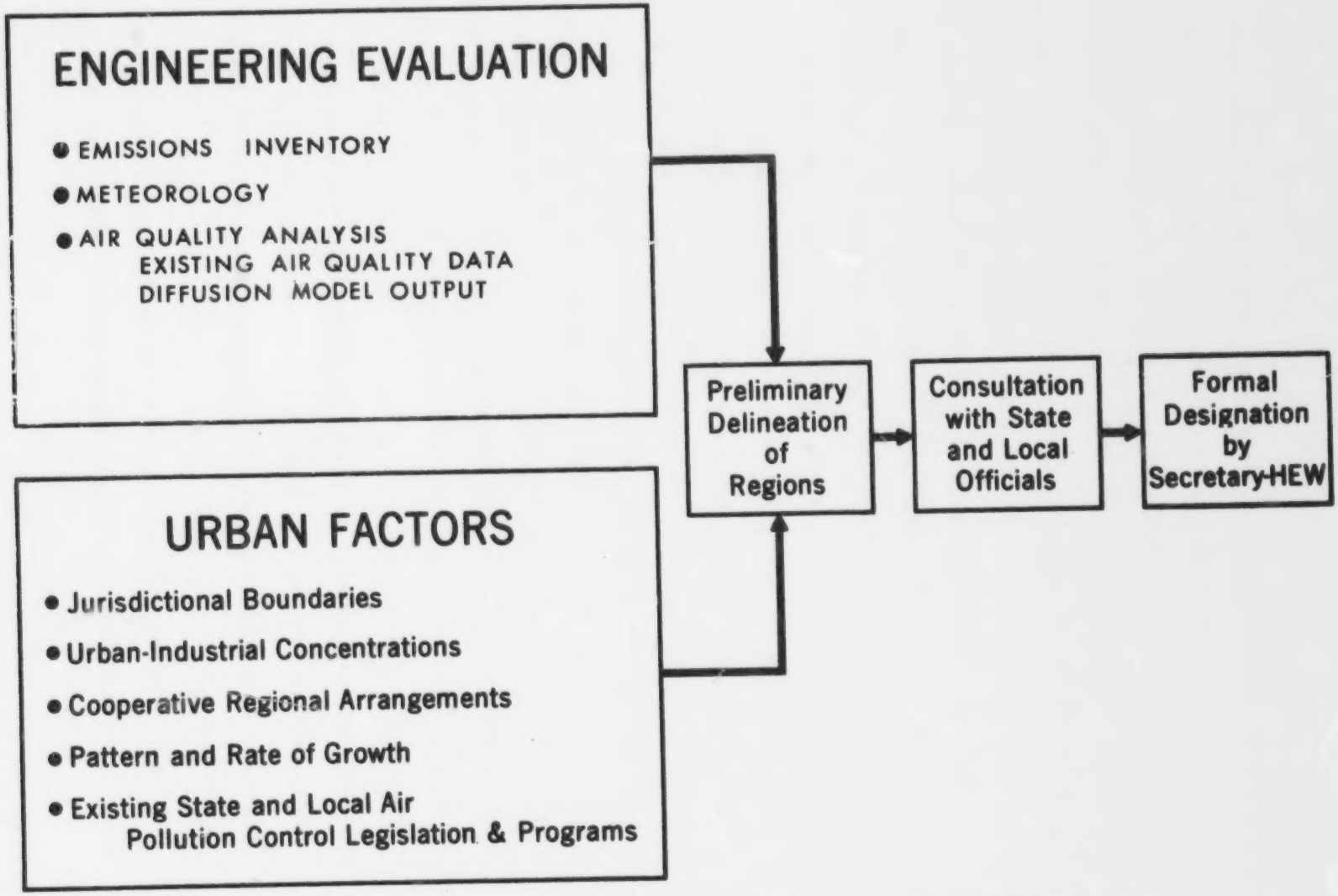

ENGINEERING EVALUATION
• EMISSIONS INVENTORY
• METEOROLOGY
• AIR QUALITY ANALYSIS
EXISTING AIR QUALITY DATA
DIFFUSION MODEL OUTPUT
URBAN FACTORS
• Jurisdictional Boundaries
• Urban-Industrial Concentrations
• Cooperative Regional Arrangements
• Pattern and Rate of Growth
• Existing State and Local Air Pollution Control Legislation & Programs
Preliminary Delineation of Regions
Consultation with State and Local Officials
Formal Designation by Secretary HEW

Figure 2. Flow diagram for the designation of air quality control regions.

A preliminary delineation of the region is developed by bringing together two essentially separate studies--the "Evaluation of Engineering Factors" and the "Evaluation of Urban Factors."

The study of "Engineering Factors" indicates the location of pollution sources and the geographic extent of serious pollutant concentrations in the ambient air. Pollution sources are located by an inventory of emissions from automobiles, industrial activities, space heating, waste disposal, and other pollution generators. Pollution concentrations in the ambient air are estimated from air quality sampling data and from a theoretical diffusion model. When it exists, air quality sampling data is more reliable than the theoretical diffusion model results since the data is directly recorded by pollution measuring instruments. Unfortunately, in many cases extensive air quality sampling data is unavailable in the rural areas surrounding an urban complex.

The study of "Urban Factors" encompasses all non-engineering considerations. It reviews existing governmental jurisdictions, current air pollution control programs, present concentrations of population and industry, and expected patterns of urban growth. Other non-engineering factors are discussed when they are relevant. As a whole, the study of urban factors indicates how large an air quality control region must be in order to encompass expected growth of pollution sources in the future. It also considers which group of governmental jurisdictions will most effectively administer a strong regional air quality control program.

The conclusions of the engineering study are combined with the results of the urban factors study to form the basis of an initial proposal for an

air quality control region. As shown in Figure 2, the proposal is then submitted for consultation with State and local officials. After reviewing the suggestions raised during the consultation, the Secretary formally designates the region with a notice in the Federal Register and notifies the Governors of the States affected by the designation.

The body of this report contains a proposal for the boundaries of the Metropolitan Kansas City Interstate Air Quality Control Region and supporting studies on engineering and urban factors. The report itself is intended to serve as the background document for the formal consultation with appropriate State and local authorities.

EVALUATION OF ENGINEERING FACTORS

The engineering evaluation for the Kansas City area was based on a study of topography, air pollutant emissions, meteorology, estimated air quality levels and available ambient air quality data. The emission inventory indicated the location of point and area sources, the quantity of pollutants emitted from these sources, and the resulting emission densities. These data were subsequently used in a diffusion model[1] to estimate air quality levels in the Kansas City area.

TOPOGRAPHY

The seven-county metropolitan area* of Kansas City covers 3227 square miles in Missouri and Kansas. Relatively flat terrain with a mean elevation of 900 feet surrounds the area. The Ozark Mountains, located about 75 miles southeast of the city, present the only major change in topography near Kansas City. There is little variation in average elevation to the north or southwest. A gradual slope of 1.5 feet per mile extends to the east and the Mississippi River, and a slow rise extends to the foothills of the Rocky Mountains to the west.

The metropolitan area is dissected into four sections by three river valleys. The Missouri River flows from west to east through the area, forming part of the Kansas-Missouri border; the valley formed by the Missouri River is two to three miles wide. The Kansas River flows into the Missouri near the center of the area and the Blue River enters the Missouri about seven miles east. These two rivers have

* In this report, the "seven-county metropolitan area" refers to the counties of Johnson, Leavenworth, and Wyandotte in Kansas, and Cass, Clay, Jackson, and Platte in Missouri. These counties were part of the Air Pollution Abatement Activity and are presently represented in the Kansas City Metropolitan Planning Commission and the Mid-America Council of Governments.

formed valleys of approximately 1.5 and 0.5 miles wide, respectively. The river bottom lands lie at about 730 feet elevation.

EMISSION INVENTORY

The National Air Pollution Control Administration conducted an inventory[2] of air pollutant emissions for the Kansas City area. Three major pollutants--sulfur oxides, carbon monoxide, and suspended particulates--have been considered in previous studies by NAPCA to aid in designating air qualtiy control regions. These three pollutants provide some measure of the general geographic extent of the overall problem. Sulfur oxides pollution levels illustrate the impact of fuel burning activities at stationary sources. Levels of carbon monoxide provide the best indication of the impact of gasoline-powered motor vehicles on the regional air pollution pattern. Particulate emissions indicate primarily the extent of industrial, power, incineration, and heating sources. Results of the emission inventory are tabulated in Table 1.

The emission inventory figures of Table 1 are the same as those presented in Phase II of the Abatement Activity, Kansas City, Kansas--Kansas City, Missouri.* Included in the inventory were estimates from the counties of Leavenworth, Wyandotte, and Johnson in Kansas, and Platte, Clay, Jackson, and Cass in Missouri. The estimated annual emissions of each of the three pollutants by grid zone were converted to average daily emissions for average, maximum, and minimum space-heating days. Average emission densities were determined by relating the total quantity of pollutants emitted in each of the grid zones to

* The emissions inventory was conducted during the calendar year 1966, and a more recent inventory has not been conducted for the area. Thus, emission figures in some categories of Table 1 may be overestimated since some reduction in emissions may have taken place in the interim.

TABLE I. POLLUTANT EMISSIONS BY SOURCE CATEGORY AND POLITICAL JURISDICTION IN THE KANSAS CITY AREA (TONS/YEAR)

	County	Ind.	Comm. & Inst.	Residential	Power Plants	Total Fuel	Ind. Proc.	Transportation	Refuse Disposal	Total
Sulfur Oxides	Cass	23	171	167	233	594	-	118	8	720
	Clay	1,200	489	193	9,081	10,963	-	425	21	11,409
	Jackson	4,511	5,882	932	39,104	50,429	16,100	1,649	200	68,378
	Platte	7	95	148	-	250	-	106	8	364
	Johnson	160	3,141	299	-	3,600	2,300	381	170	6,451
	Leavenworth	62	154	229	-	445	-	192	19	656
	Wyandotte	3,021	451	306	16,102	20,680	15,100	1,353	50	37,183
	Total	9,784	10,383	2,274	64,520	86,961	33,500	4,224	476	125,161
Particulates	Cass	43	34	41	58	176	18	204	310	708
	Clay	1,095	100	85	650	1,930	1,890	1,054	783	5,657
	Jackson	2,510	909	491	2,079	5,989	5,480	3,007	6,726	21,202
	Platte	10	19	36	-	65	-	447	230	742
	Johnson	146	2,364	139	-	2,649	230	660	6,750	10,289
	Leavenworth	39	43	56	-	138	490	361	795	1,784
	Wyandotte	1,217	94	149	2,700	4,160	10,500	2,568	2,055	19,283
	Total	5,060	3,563	997	5,487	15,107	18,608	8,301	17,649	59,665
Carbon Monoxide	Cass	62	47	2	1	112	-	23,057	520	23,689
	Clay	63	153	25	15	256	-	46,025	1,284	47,565
	Jackson	343	1,494	123	160	2,120	-	285,965	12,880	300,965
	Platte	52	29	Neg.	-	81	-	17,204	370	17,655
	Johnson	123	163	3	-	289	-	75,883	11,821	87,993
	Leavenworth	88	34	3	-	125	-	32,453	1,411	33,989
	Wyandotte	123	171	63	64	421	-	228,036	3,980	232,437
	Total	854	2,091	219	219	3,404	-	708,623	32,266	744,293

the land area of each zone. The resulting emission densities are shown in Figures 3, 4, and 5. The general pattern of emission densities for each of the three pollutants is closely related to the pattern of urbanization in the Kansas City area.

Major point sources in the study area which are contributing to the air pollution problem are shown in Figure 6.

Table 2 shows estimated annual emissions of particulates, SO_X, and NO_X from point sources in Douglas County. The inventory was conducted by the Kansas State Department of Health.

Table 2. Estimated Contaminant Emissions for Douglas County (tons/year)

Source	Particulate	SO_X	NO_X
Agricultural Ind. (3 Alfalfa dehydrators and 3 elevators)	345		
Building Materials (2 Ready mix concrete and 1 asphalt)	79		
Institutional Power Plant	29	1	741
Refuse Disposal (Open Burning)			
Municipal	240	6	
Auto Salvage	7		
Municipal Power Plant	13	3	176
Space and Process Heat (3 Major Industries)	4	14	34
Total (point sources)	717	24	951

AIR QUALITY ANALYSIS

The geographical distribution of pollutant sources illustrates the core of the problem area. It does not, however, elucidate the extent of the influence of pollution sources on the people and property

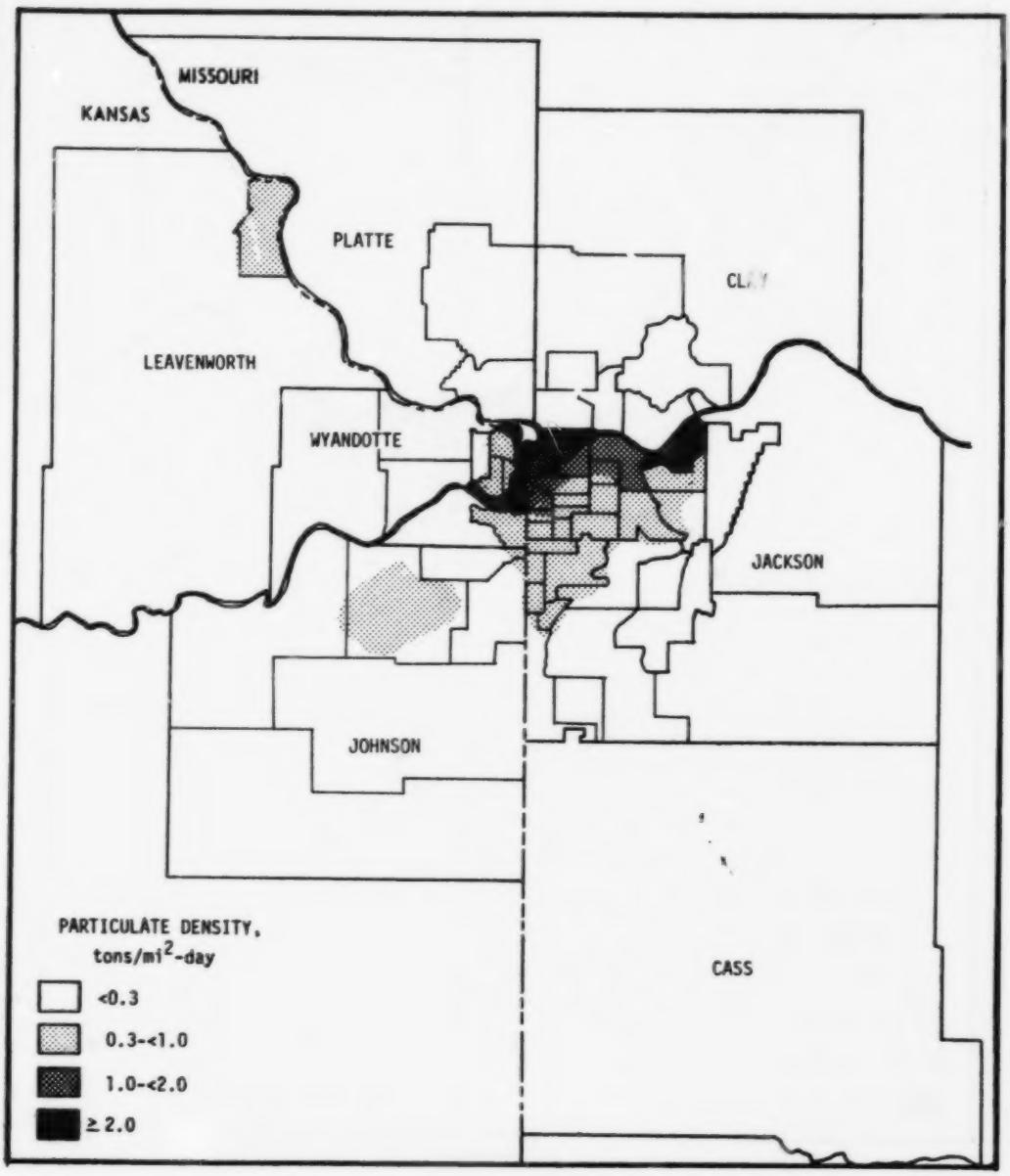


Figure 3. Particulate emission densities for average space-heating day.[3] (Counties were divided into emission inventory zones shown above.)

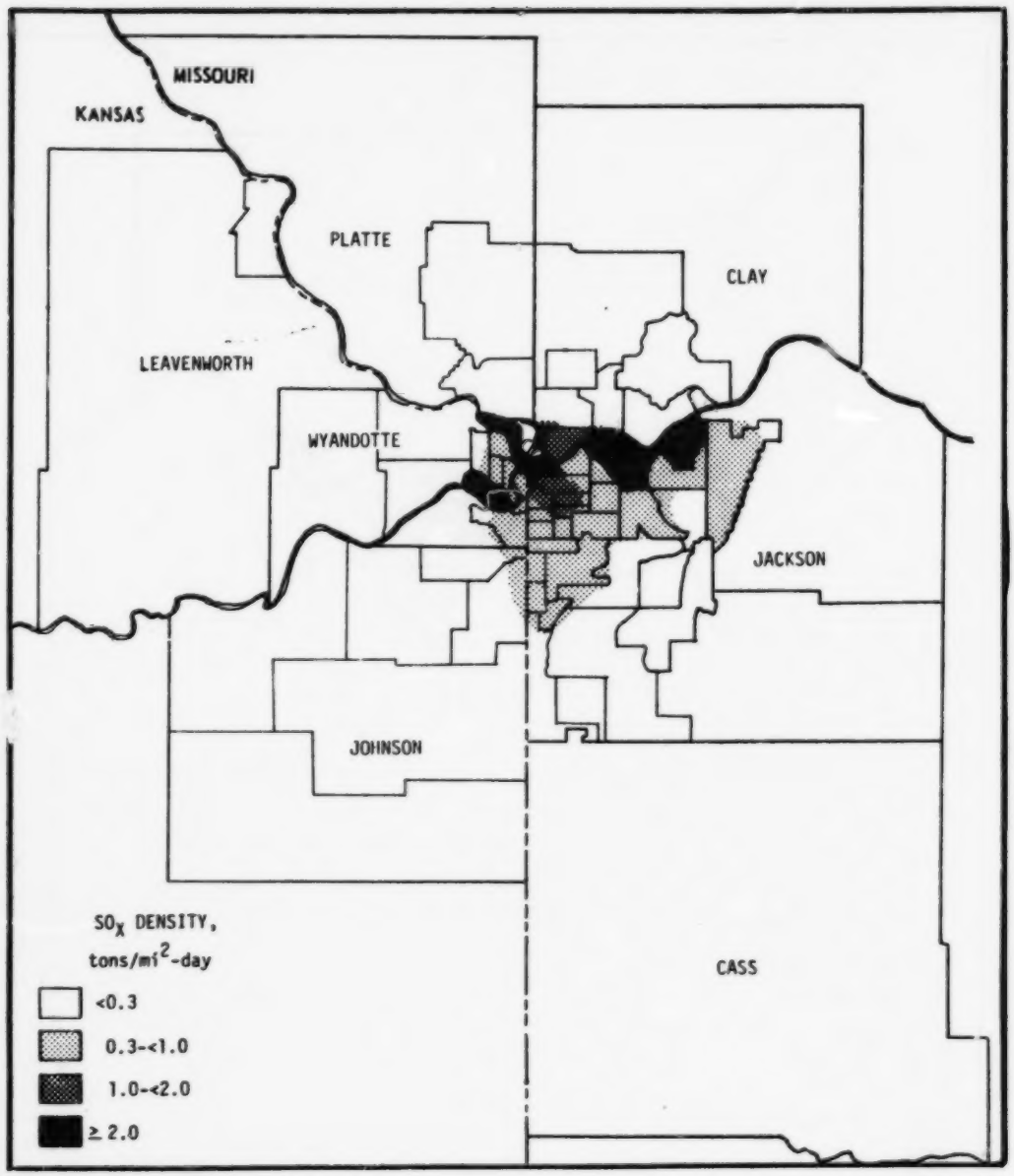


Figure 4 . Sulfur oxides emission densities for average space-heating day.[3] (Counties were divided into emission inventory zones shown above.)

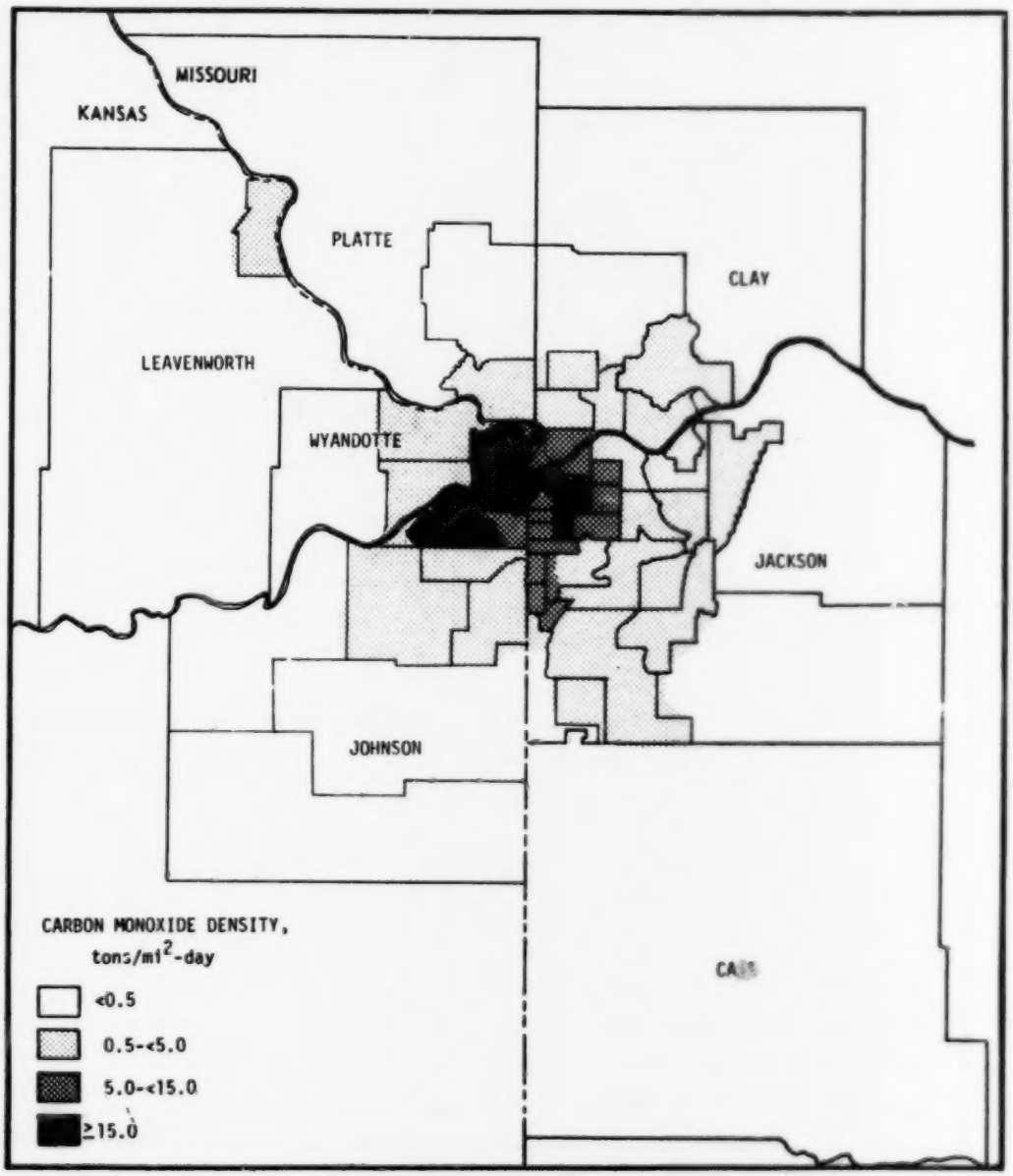


Figure 5. Carbon monoxide emission densities for average day.[3] (Counties were divided into emission inventory zones shown above.)

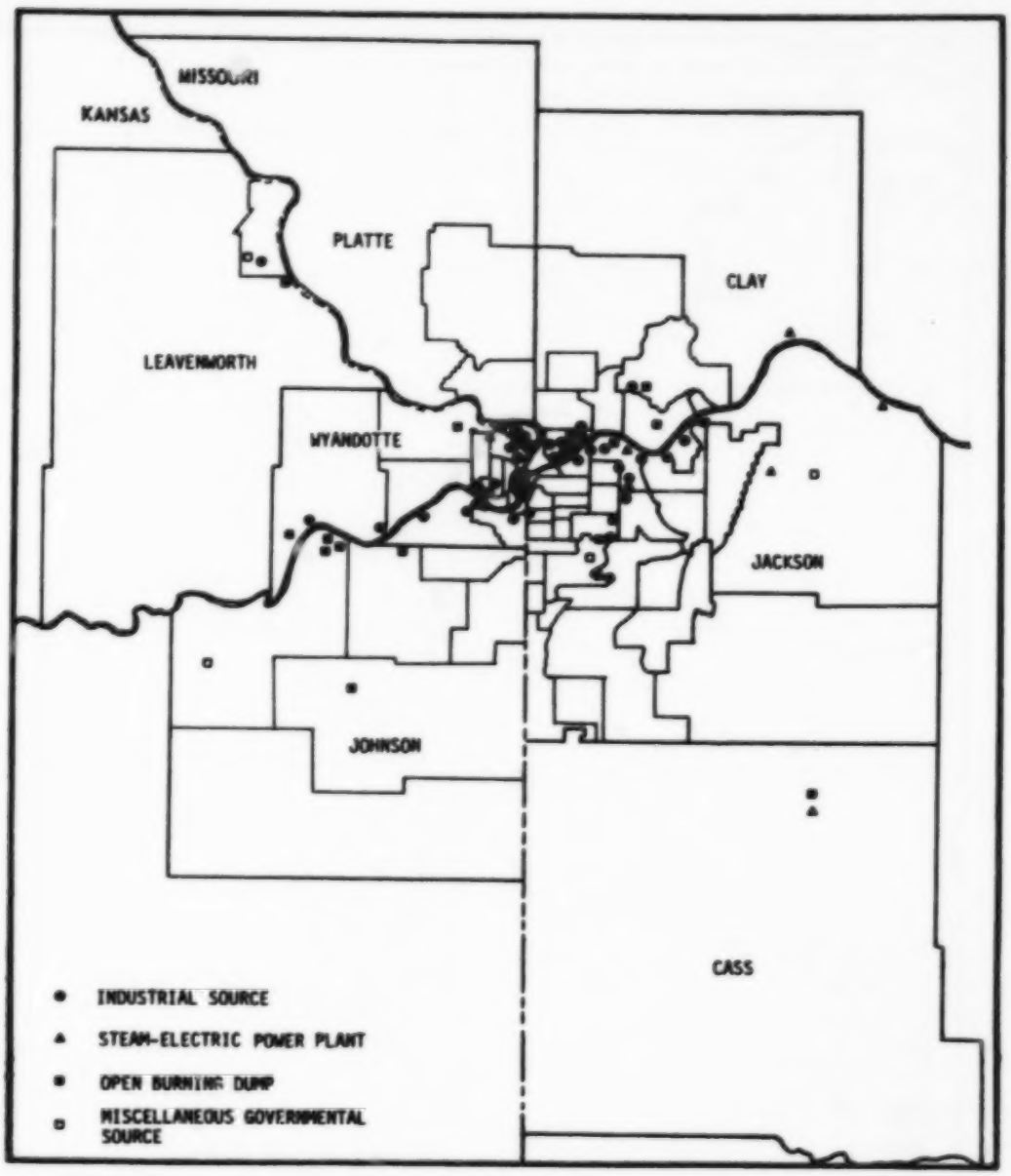


Figure 6. Point sources that emit 100 tons or more per year of a single pollutant. (The emission inventory zones shown above were used to calculate emission densities--Figures 3, 4, and 5.)

located outside the highly urbanized portion of the Kansas City area. A study of air qualtiy levels known or estimated to occur is useful in determining the area affected by the pollution sources and thus subject to inclusion in the Air Quality Control Region. Such analysis can be based directly on air sampling data in those instances where the sampling program covers a large enough area and has been in existance long enouth to provide reliable patterns of air quality throughout the region under study. Since such comprehensive air quality data rarely exists, it becomes necessary to develop estimates of privailing air quality. Diffusion modeling is a technique by which such estimates can be made based on the location and quantity of pollutant emissions and on meteorological conditions. Topography is reflected in the results of the model, but only to the extent that it influences meteorological conditions.

The diffusion model was applied for each of the three pollutants for an average summer day, winter day, and annual day. Figure 7 and Table 3 show the meteorological data required to apply the model for each of the three average days. Figure 7 shows the percent frequency of occurrence of wind direction from 1951 through 1960 in Kansas City for summer, winter, and annual conditions. The wind speed and direction data used in the diffusion model were considered representative of the prevailing wind patterns throughout the general Kansas City area. Since the Martin-Tikvart model[1] used in this study attempts to show long-term rather than episodic air qualtiy conditions, only average emissions and long-term meteorology are considered. If episodic data (i.e., data related to more stagnate but less frequent occurence) were

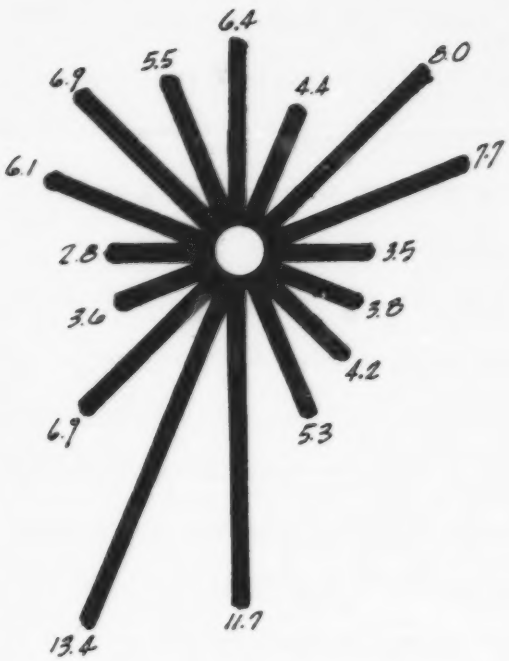
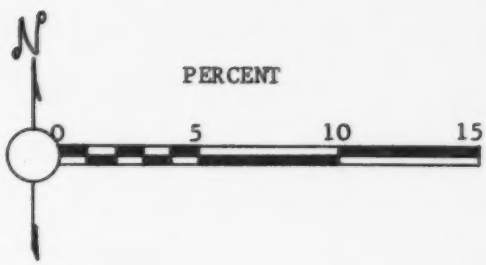
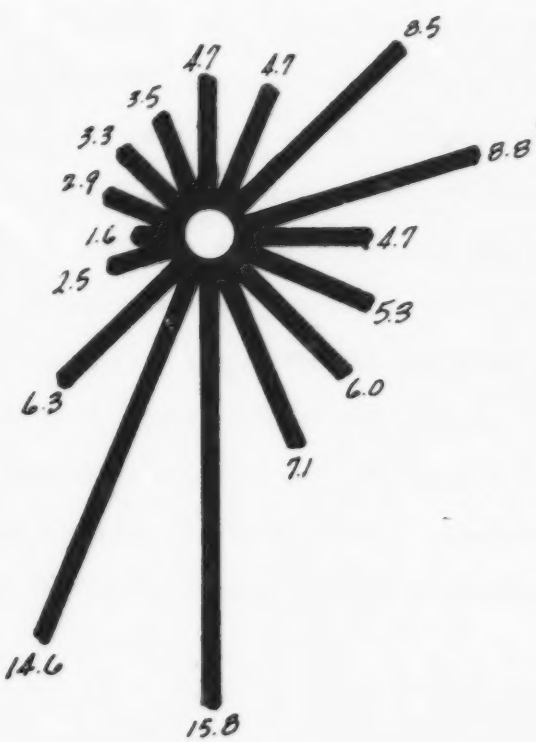
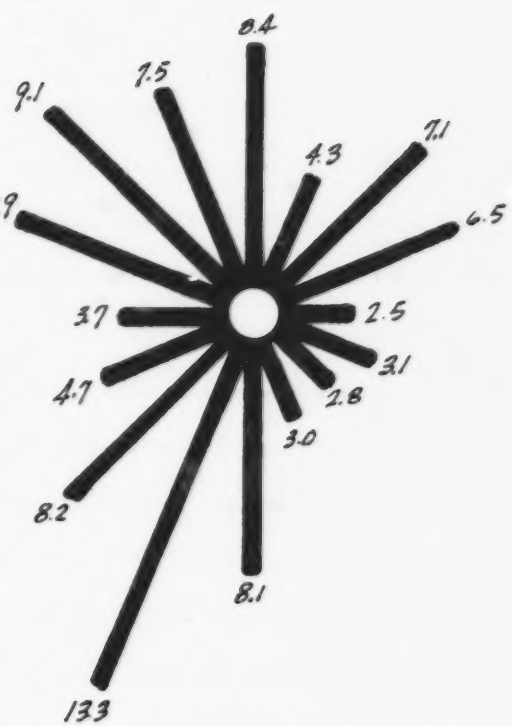


Figure 7. Percent frequency of wind direction for various averaging times, based on 1951-1960 data.







used to aid in delineating a region boundary, the region would be unnecessarily large. Even the "smaller" region defined on the basis of mean concentrations will undoubtedly encompass the area of maximum concentration upon which a reduction plan is to be developed.

The mixing depths for the time periods are averages of the morning and afternoon values as shown in Table 3; these data were

Table 3. Average Mixing Depths for Kansas City Area by Season

Season	Mixing Depths, meters		
	Average Morning	Average Afternoon	Average, Morning and Afternoon
Winter (Dec.,Jan.,Feb.)	350	760	555
Summer (June,July,Aug.)	350	1550	950
Annual (Four Seasons)	371	1253	812

obtained from tabulations prepared by the National Weather Records Center (ESSA). Combined with wind data, these data are used in the diffusion model to assess the spatial distribution of concentrations of suspended particulates, sulfur oxides, and carbon monoxide.

Suspended Particulates

Figure 8[3] shows the measured suspended particulate distribution based on data from 16 stations taken from October 1966 to October 1967. This figure was published in the abatement activity report, Phase II. Concentrations of 100 $\mu g/m^3$ and greater occured in the core of the study area, i.e., in Kansas City, Kansas, and Kansas City, Missouri, along the Kansas and Missouri Rivers.

Theoretical concentration contours produced by the diffusion model

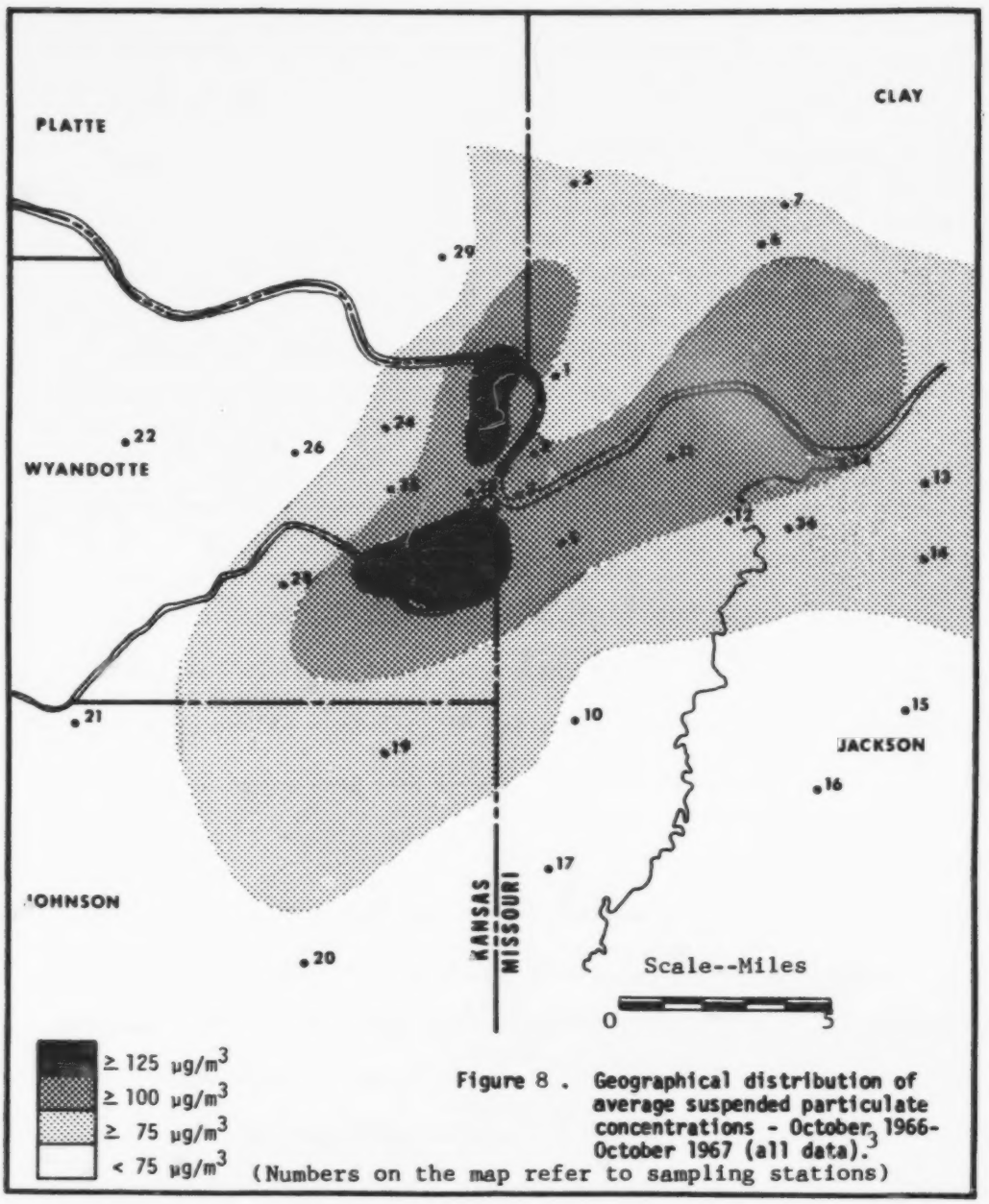


Figure 8. Geographical distribution of average suspended particulate concentrations - October 1966-October 1967 (all data).

(Numbers on the map refer to sampling stations)

are shown in Figure 9. Contour values were adjusted* to approximate those of the core area in Figure 8. The theoretical contours are less well defined in the core of the area than contours drawn from sampling data, but they encompass more area since values go down to 40 $\mu g/m^3$. The background level is assumed to be approximately 40 $\mu g/m^3$ in the area surrounding Kansas City. In previous reports proposing air quality control regions, the area within the background level contour line was considered for inclusion in the region. It must be reiterated that the theoretical contours are based on emissions from the seven-county area only. Had emissions from St. Joseph, Topeka, and Lawrence been included in the model input, the contour shapes and geographical extent would have changed slightly.

Sulfur Oxides

Figure 10[3] shows average measured sulfation levels for January and February, 1967, in the core of the study area. The highest measured values ($\geq$0.75 mg SO_3/100 cm^2--day) appear in downtown Kansas City, Missouri, near the confluence of the Missouri and Kansas Rivers.

Shown in Figure 11 are theoretical SO_X contours in ppm based on diffusion model output. The values were adjusted to conform with the sulfation levels of Figure 10**, but the shape of the contours were not changed. In general the isopleths are elongated in an east-west direction along the Missouri River.

The 0.01 ppm SO_X contour has been used in past region designations

---

* All diffusion model values were multiplied by a factor of 4.0 so that the values of the innermost contours would correspond to those shown for measured data in Figure 8.

** 0.75 mg SO_3/100 cm^2--day and 0.50 mg SO_3/100 cm^2--day are equivelent to average SO_2 concentrations of approximately 0.03 and 0.02 ppm, respectively. (see Reference 4.) Sulfur dioxide (SO_2) constitutes the overwhelming majority of sulfur oxides pollution.

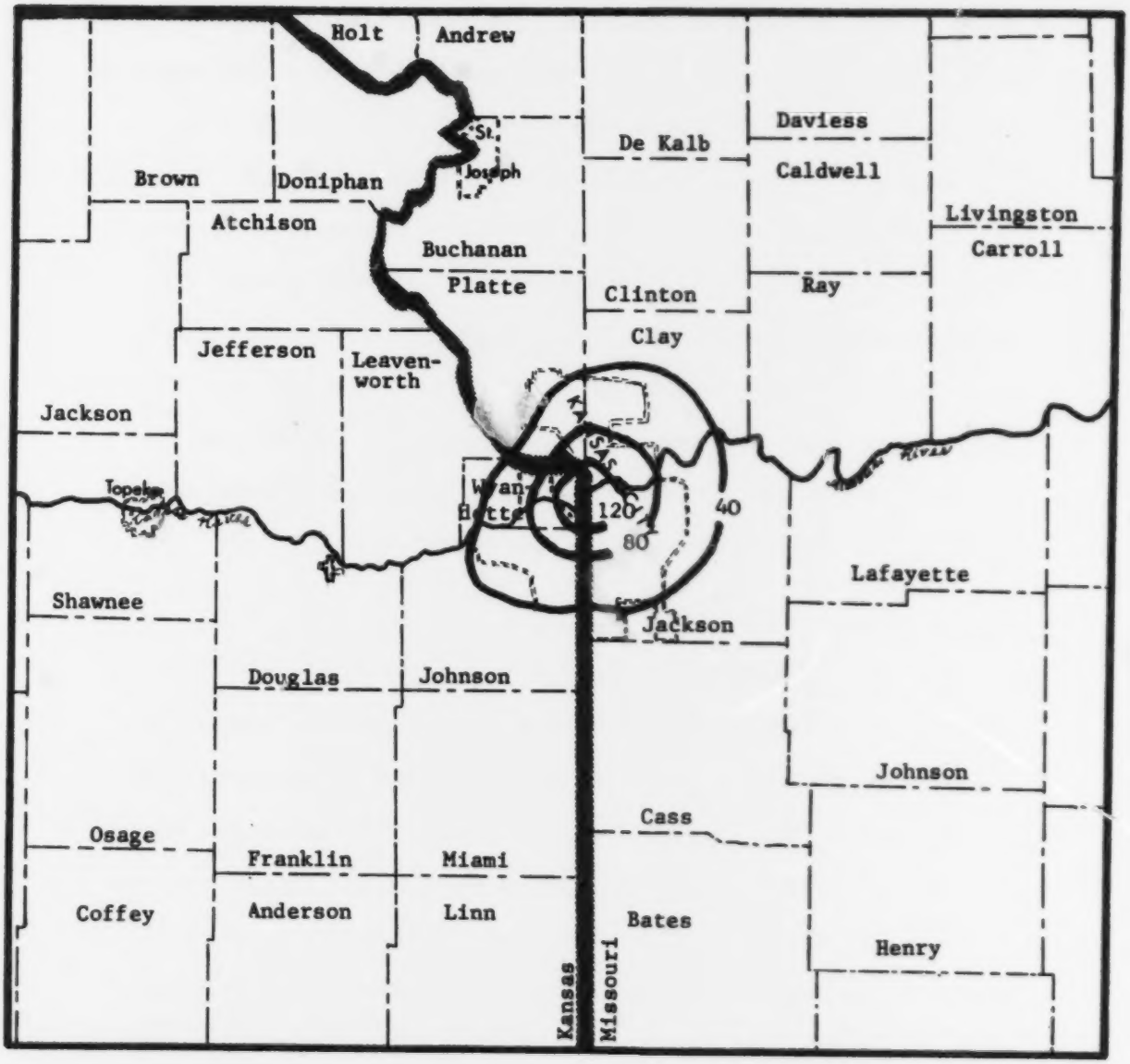


Figure 9. Theoretical Suspended Particulate Concentration--Annual Average

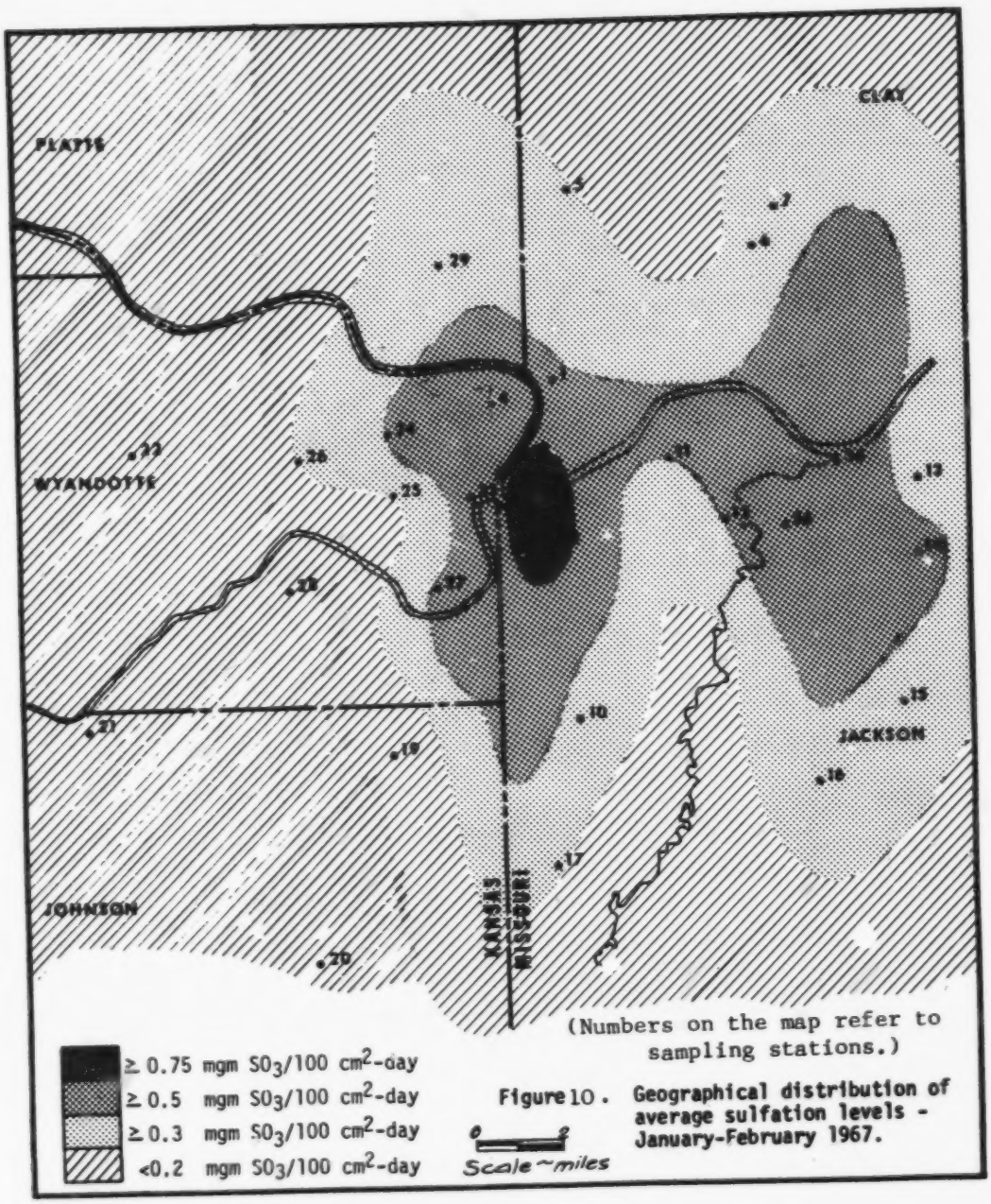


Figure 10. Geographical distribution of average sulfation levels - January-February 1967.

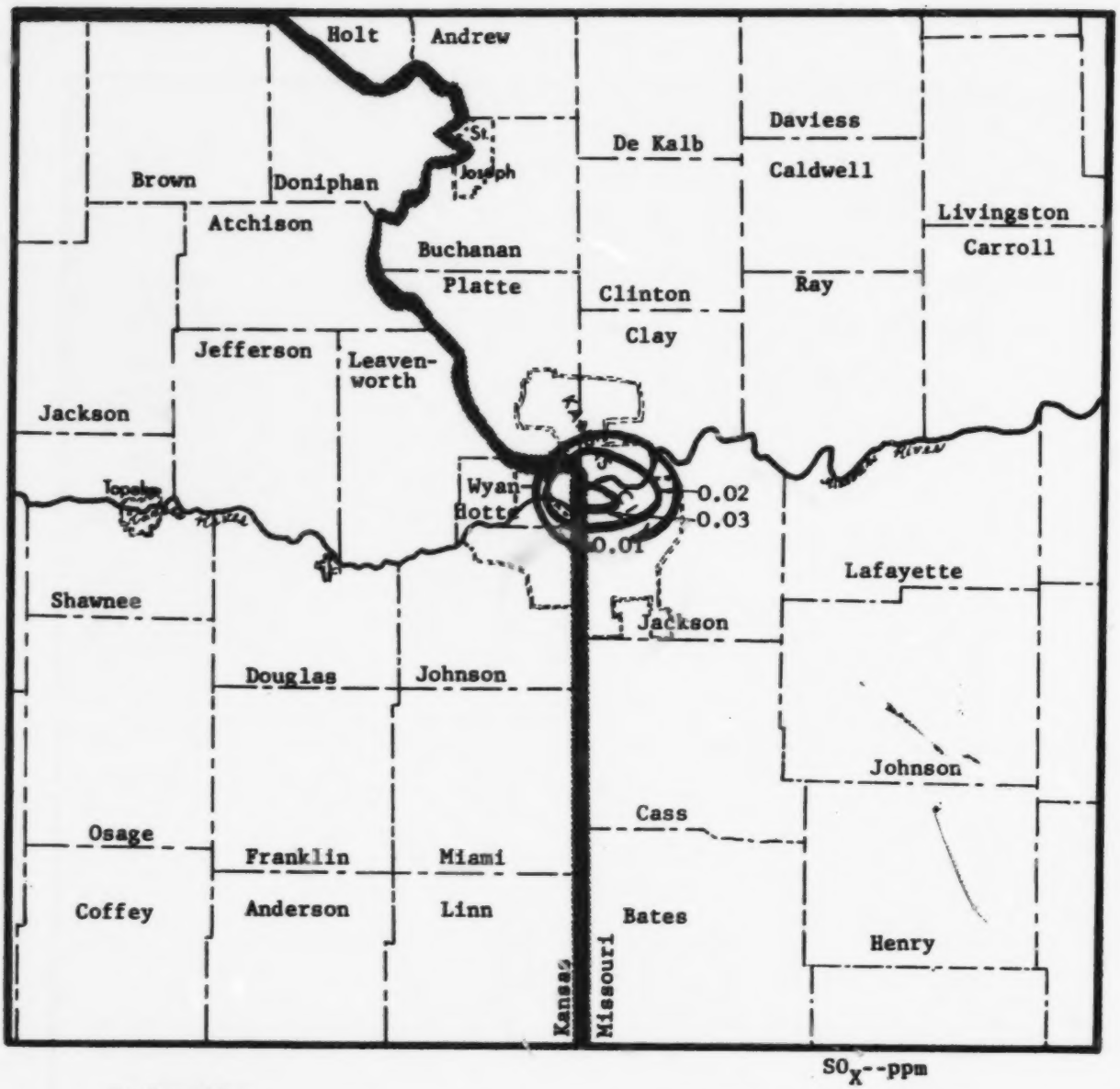


Figure 11. Adjusted theoretical SO_X concentration, winter average.

as a guide to the area most affected by SO_X emissions in an urban area. Though geographically less extensive in Kansas City than in many urban areas (e.g., St. Louis, Cleveland, Pittsburg, and Boston), the 0.01 ppm SO_X contour, includes parts of five counties--Wyandotte and Johnson in Kansas, and Platte, Clay, and Jackson in Missouri.

Carbon Monoxide

Figure 12 shows theoretical relative carbon monoxide contours. Isopleths based on emissions and meteorology from an average annual day are presented here since emissions are considered to be nearly constant throughout the year.[3] Figure 12 indicates that the highest relative carbon monoxide concentrations occur in the downtown Kansas City, Kansas--Kansas City, Missouri, area where traffic volume is greatest. As in the case of suspended particulates and sulfur oxides, had emissions from cities in the surrounding counties been included in the diffusion model input data, the shapes of the contours would have been altered.

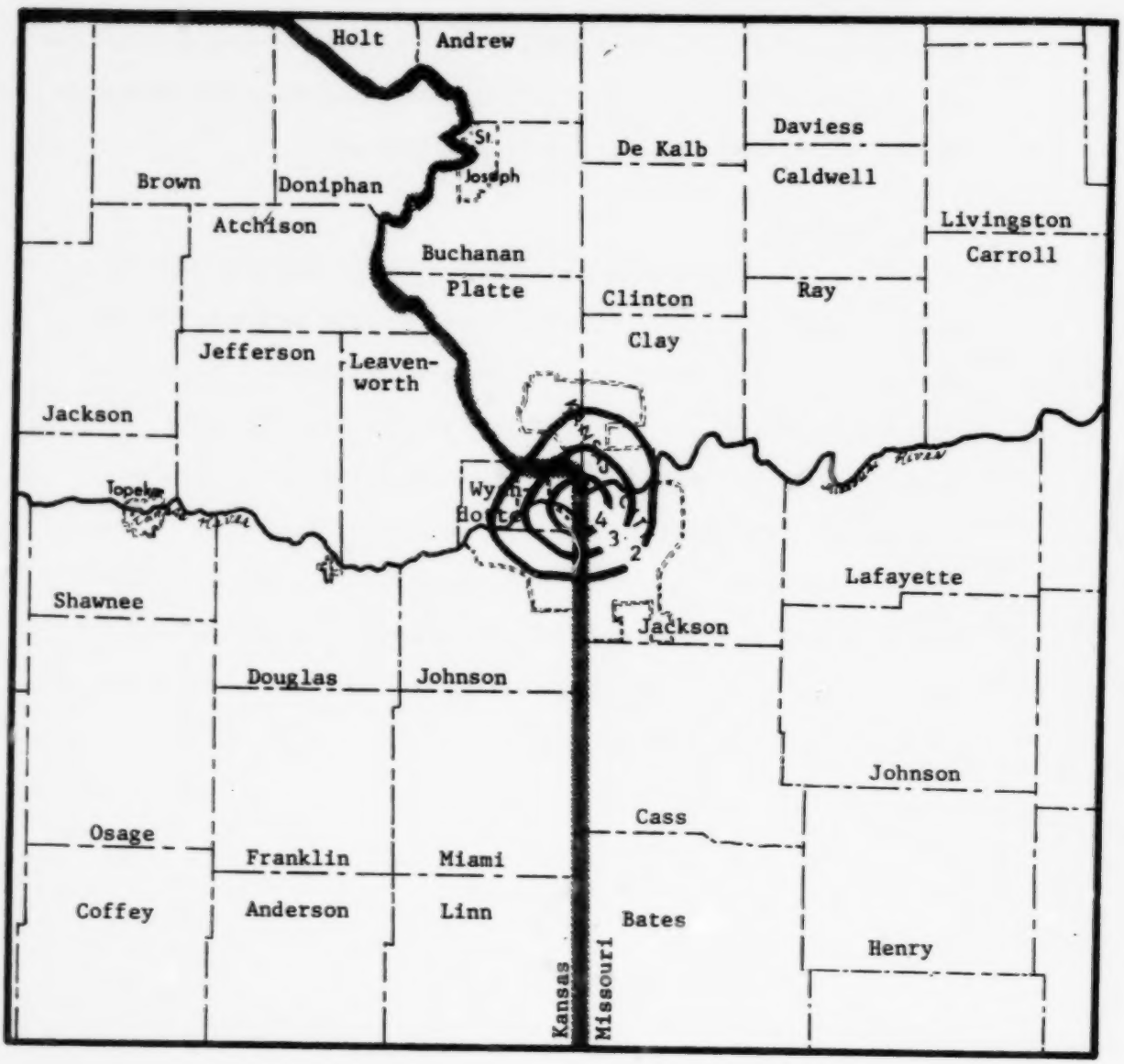


Figure 12. Theoretical Relative Carbon Monoxide Contours--Annual Average

EVALUATION OF URBAN FACTORS

INTRODUCTION

A number of urban factors are relevant to the problem of defining air quality control region boundaries. First, the location of population is an important consideration, since human activity is the ultimate cause of air pollution, and humans are the ultimate victims. The population growth pattern is another important consideration, since an air quality control region should be designed not only for the present but also for the future. The location of industrial activity and the industrial growth pattern are relevant considerations for similar reasons. Political and jurisdictional considerations are important also, since the 1967 Air Quality Act envisions regional air pollution programs based on cooperative efforts among many political jurisdictions. The following discussion of urban factors will present these considerations as they apply to the Kansas City area.

POPULATION

Figure 13 and Table 3 display present population and population densities by county in the Kansas City area.[7,11] The seven-county metropolitan area has a population of over 1,300,000 people. Of these, about one half live in the cities of Kansas City, Kansas, and Kansas City, Missouri. Three counties outside of the 7-county metropolitan area have significant population densities: Shawnee County (Topeka), Douglas County (Lawrence), and Buchanan County (St. Joseph). All three have higher population densities than two counties in the metropolitan area--Cass and Platte. Though Figure 13 shows equal ranges of population density in the counties of Shawnee, Johnson, and Clay (250-1000 residents

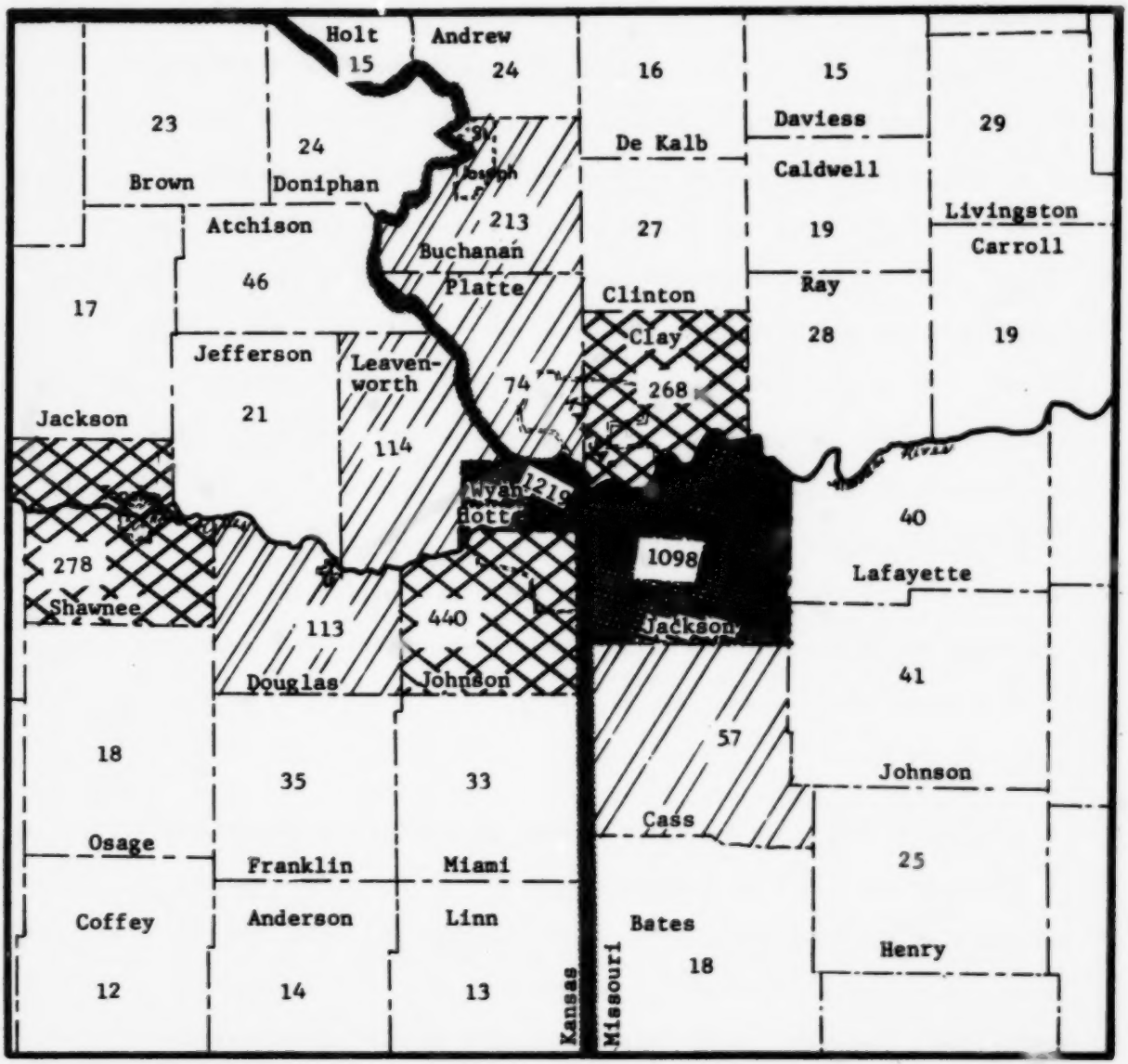


Figure 13. 1968 Population Density

Scale-miles

0 5 10 20 30 40

State Boundary

County Boundary

City Boundary

Residents per square mile

>1000

250—1000

50—250

<50

Table 3. Population and Employment Data for Kansas City Area

	County	Area mi.^{2}	Population 1968	Pop. Density 1968 res./mi.^{2}	Population 1980	Pop. Density 1980 res./Mi.^{2}	Additional residents per mi.^{2}	% Growth 1968-1980	Manufacturing Employment 1963	Density; manufact. employ./ mi.^{2}
KANSAS	Anderson	576	7,800	14	8,500a	15	1	9	199	0.4
	Atchison	427	19,800	46	20,400a	48	2	3	1617	4.0
	Brown	577	13,300	23	13,300a	23	neg	0	309	0.5
	Coffey	656	7,900	12	7,700a	12	12	-3	42	0.1
	Doniphan	388	9,300	24	9,400a	24	neg	1	9	neg
	Douglas	471	53,100	113	55,000a	117	4	4	2318	4.9
	Franklin	577	20,300	35	20,500a	36	1	1	551	1.0
	Jackson	656	11,300	17	10,100a	15	-2	-10	285	0.4
	Jefferson	549	11,700	21	11,300a	21	neg	-4	66	0.1
	Johnson	476	210,000	440	371,500b	779	339	77	2895	6.1
	Levenworth	465	53,100	114	70,000b	151	37	32	1176	2.5
	Linn	606	7,700	13	8,100a	13	neg	5	86	0.1
	Miami	592	19,800	33	19,800a	33	neg	0	507	0.9
	Osage	720	12,800	18	12,800a	18	neg	0	191	0.3
	Shawnee	547	152,000	278	209,760c	383	105	31	6588	12.0
	Wyandotte	152	185,000	1219	254,000b	1670	451	37	24282	160.0
MISSOURI	Andrew	435	10,600	24	9,250d	21	-3	-13	13	neg
	Bates	841	14,900	18	13,300d	16	-2	-11	242	0.3
	Buchanan	404	86,000	213	104,500d	258	45	21	10679	26.0
	Caldwell	430	8,100	19	6,700d	16	-3	-17	820	1.9
	Carroll	694	12,800	19	10,000d	14	-5	-22	495	0.7
	Cass	698	39,500	57	62,000b	89	32	57	416	0.6
	Clay	413	110,000	268	223,000b	540	272	103	10427	25.2
	Clinton	420	11,500	27	10,500d	25	-2	-9	98	0.2
	Daviess	563	8,400	15	6,300d	11	-4	-25	334	0.6
	Dekalb	423	6,700	16	5,300d	13	-3	-21	17	neg
	Henry	737	18,700	25	16,700d	23	-2	-11	845	1.2
	Holt	464	6,700	15	5,000d	11	-4	-25	16	neg
	Jackson	603	660,000	1098	925,500b	1537	439	40	73018	121.0
	Johnson	826	33,900	41	70,000d	85	44	106	929	1.1
	Lafayette	634	25,100	40	49,000d	77	37	95	746	1.2
	Livingston	533	15,200	29	12,600d	24	-5	-17	814	1.5
	Platte	420	31,000	74	79,000b	188	114	155	66	0.2
	Ray	574	16,100	28	31,000d	54	26	93	84	0.2

a. Figures projected by State of Kansas Department of Economic Development[9]

b. Figures projected by Kansas City Metropolitan Planning Commission[5]

c. Figures projected by Topeka-Shawnee County Metropolitan Planning Agencies[8]

d. Figures extrapolated by NAPCA from projections by the Missouri State Highway Department

per square mile), and in St. Joseph, Platte, Leavenworth, Douglas, and Cass (50-250 residents per square mile), clearly the population is not spread equally throughout these counties. Most of Shawnee's population is located in Topeka, Douglas' in Lawrence, Johnson's in the Kansas City suburbs, Leavenworth's in Leavenworth, Buchanan's in St. Joseph, and Clay's in the Kansas City, Missouri suburbs. Rural areas separate these cities.

Population growth* by county during the next decade is presented in Table 3 and Figures 14 and 15.[5,6,8,9] Based on percent rate of growth, the most rapidly growing counties are expected to be Platte, Johnson (Missouri), and Clay, followed by Lafayette, Ray, Johnson (Kansas), Cass, Jackson, Wyandotte, Leavenworth, and Shawnee, respectively. Considering absolute growth, i.e., additional residents per square mile, Wyandotte and Jackson are expected to grow most rapidly, followed by Johnson (Kansas), Clay, Platte, and Shawnee, respectively. According to Figures 14 and 15, Douglas County will grow by less than 10 additional residents per square mile (4% rate of growth) over the next decade. The growth projections[9] made by the State of Kansas Department of Economic Development tend to be on the conservative side, at least for Douglas County. The 1968 population in Douglas County (estimated 53,100[11]) approached the projected 1980 population (55,000[9]). It is anticipated that the county will be eligible for designation as a Standard Metropolitan Statistical Area or a part of one by 1970.**

---

* If more than one set of population growth figures was available for a county, data from a regional planning commission was considered most reliable and was used in this report--e.g., Shawnee County and the seven counties in the Kansas City Metropolitan Planning Commission.

** The Department of the Census and other Federal agencies have established a system of Standard Metropolitan Statistical Areas (SMSA) for use in publishing census data and a variety of other government statistics.

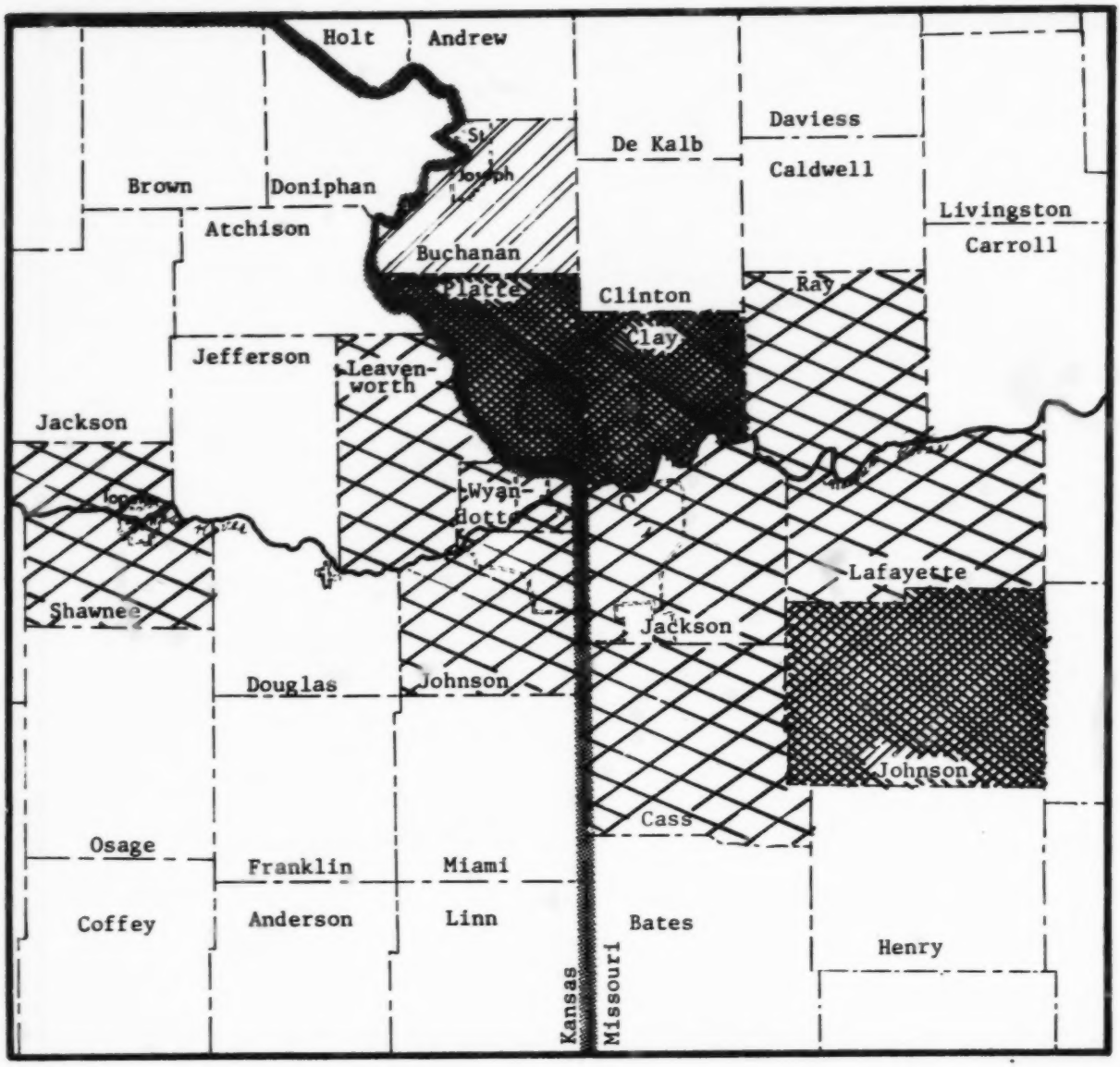


Figure 14. Population Growth From 1968 to 1980 in Percent.

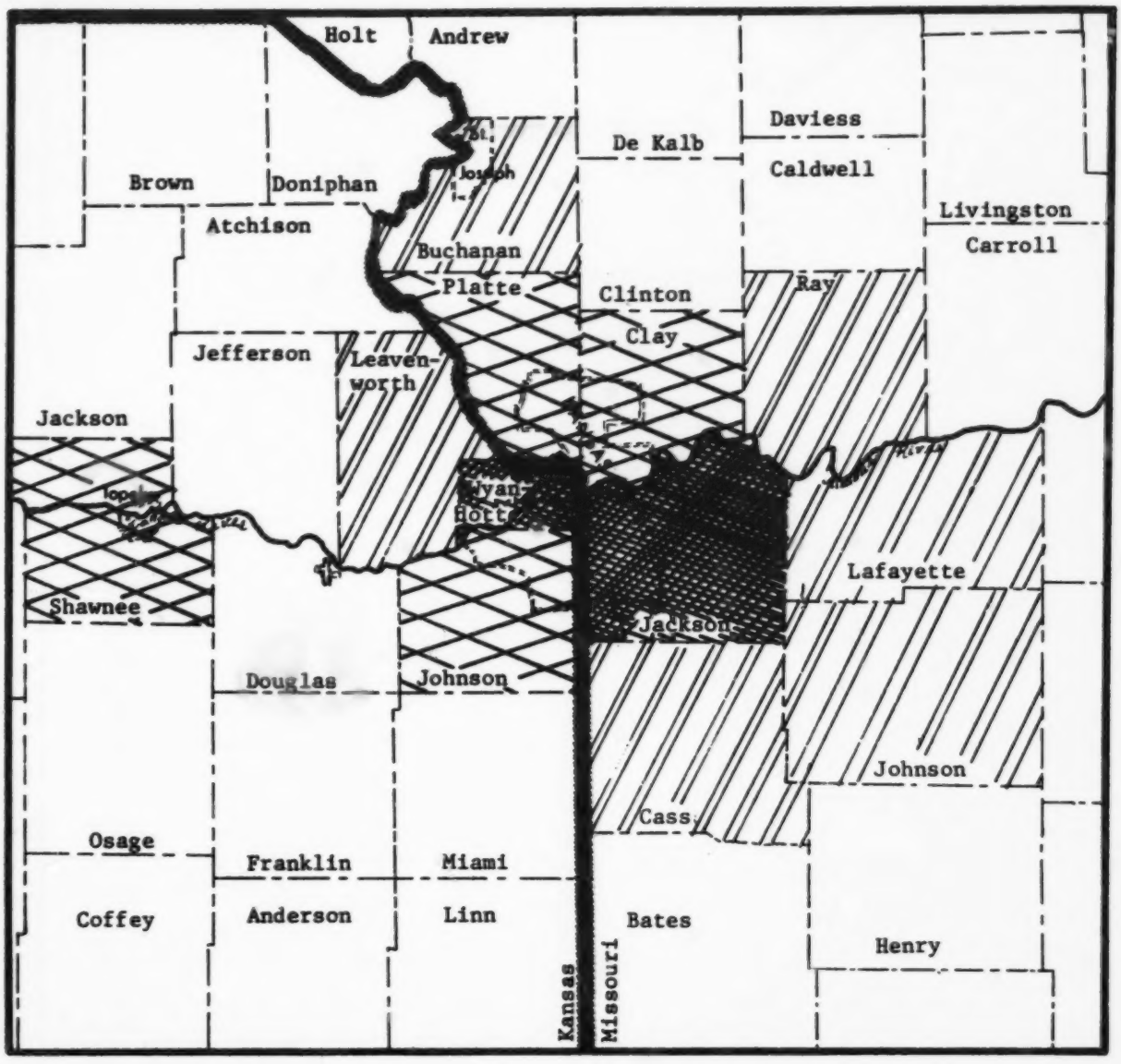


Figure 15. Population Growth, 1968-1980, Expressed in Absolute Terms

The Kansas City Metropolitan Planning Commission has made sub-county population projections to 1990 for the seven-county metropolitan area by dividing the area into growth sectors and growth rings.[7] These projections, by additional residents per sector and ring, are shown in Figures 16 and 17. Figure 16 indicates that the sector expected to receive the largest population growth includes the southeastern part of Johnson County and the western portions of Jackson and Cass Counties along the state line. The sectors lying south of the Kansas and Missouri Rivers in Johnson, Wyandotte and Jackson Counties will follow.

Figure 17 indicates that the third outermost ring (C) is expected to experience the most population growth in the next two decades. Ring C will approach "saturation" by 1990 but will still have some room for development, especially in the northern half. Ring D is expected to grow by 400,000 residents (295% increase, 1963-1990).

INDUSTRY

Two methods are used to indicate location of manufacturing activity. First, the land use map[3,10], Figure 18, displays industrial (both light and heavy) areas in the metropolitan Kansas City area. Major industrial areas are located on the Kansas, Missouri, and Blue Rivers in Jackson, Clay, and Wyandotte Counties. The outer portions of Jackson, Clay, and Johnson Counties are spotted with industrial activity. Leavenworth, Platte, and Cass have some industry.

A second method of presenting the location of manufacturing can be based on the density of people employed in manufacturing firms. According to 1963 data,[11] Wyandotte and Jackson Counties have by far the highest density of manufacturing employees followed by Clay County. Outside the

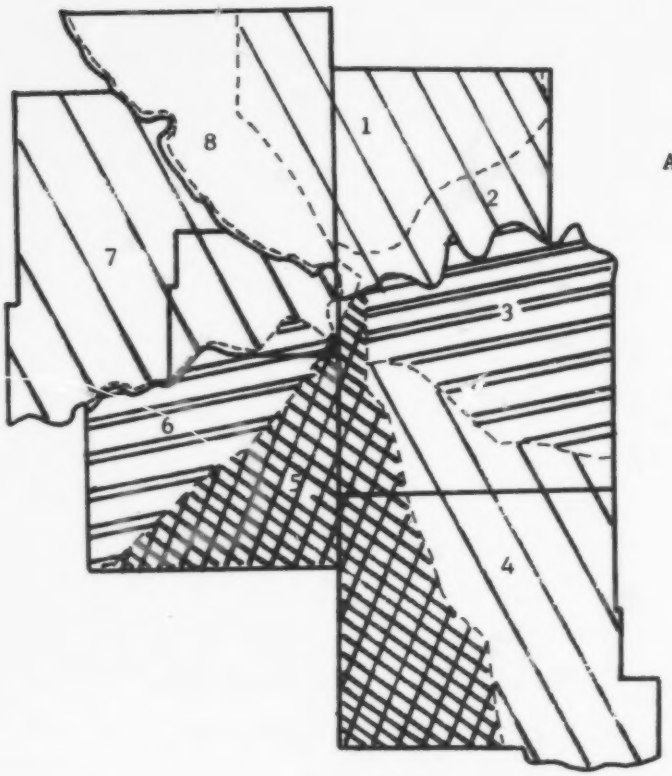


Figure 16. Growth by Sector. 1963-1990

Additional Residents per sector

- >500,000
- 200,000-500,000
- 100,000-200,000
- <100,000

County Line

Sector Line

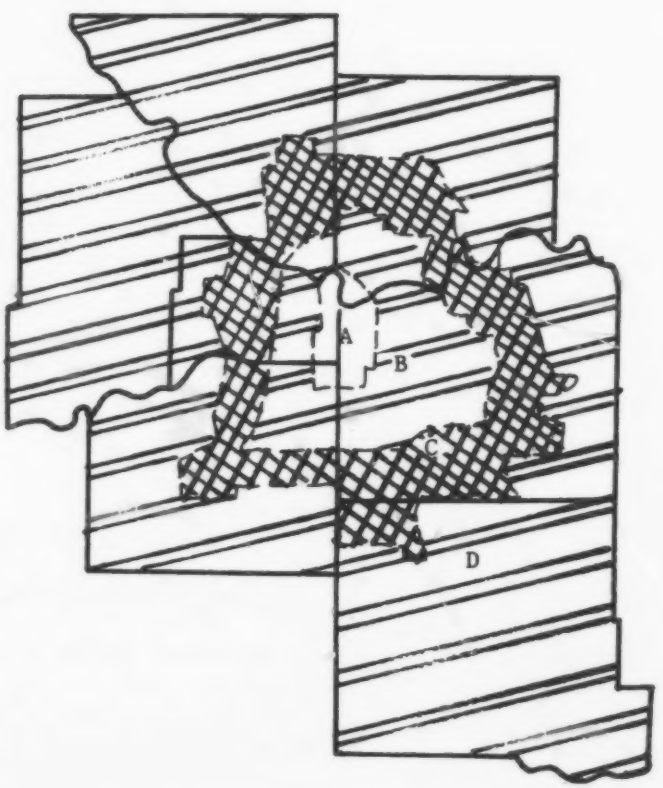
Figure 17. Growth by Ring 1963-1990

Additional Residents per Ring

- >500,000
- 200,000-500,000
- 100,000-200,000
- < 100,000

County Line

Ring Line



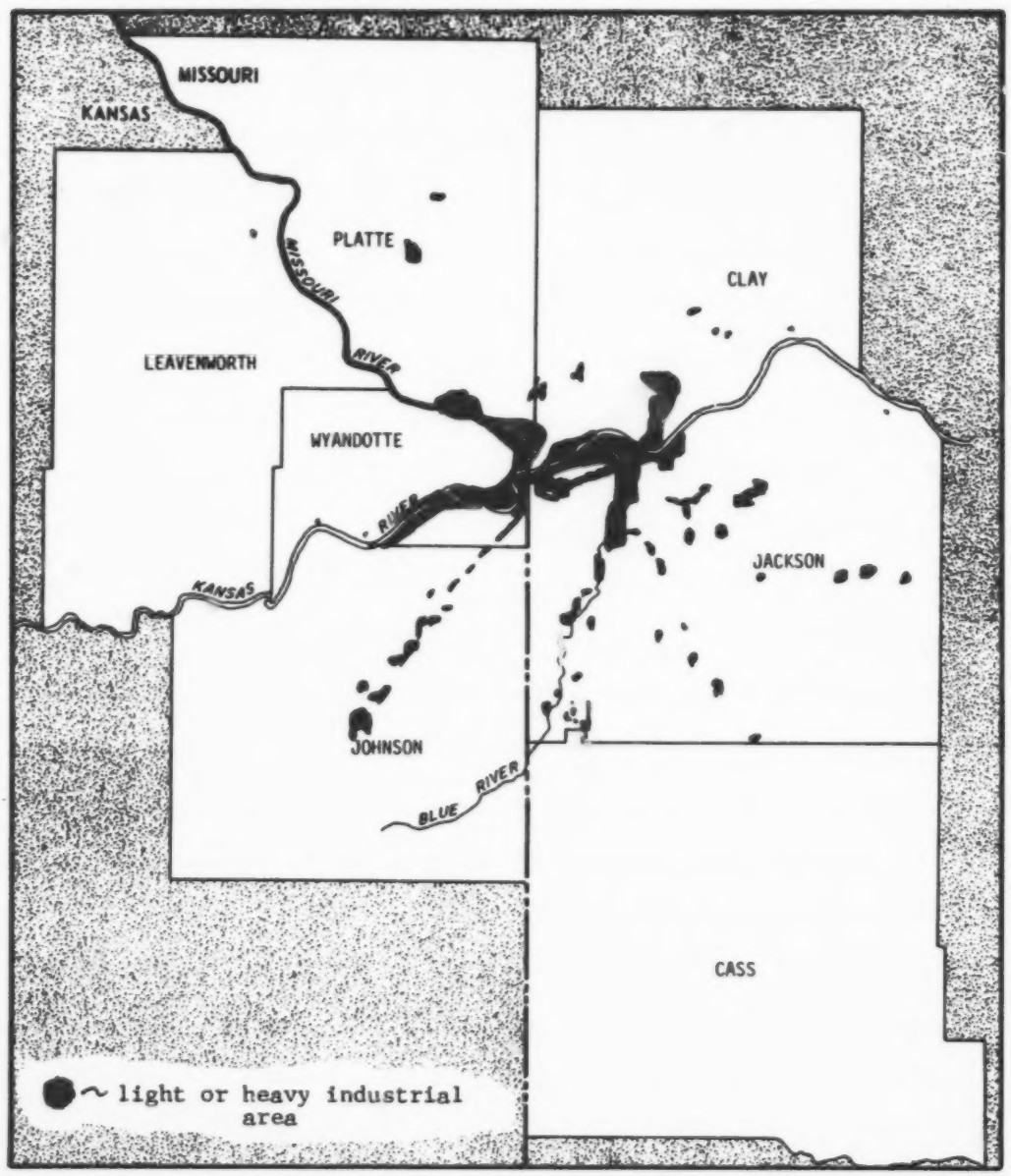


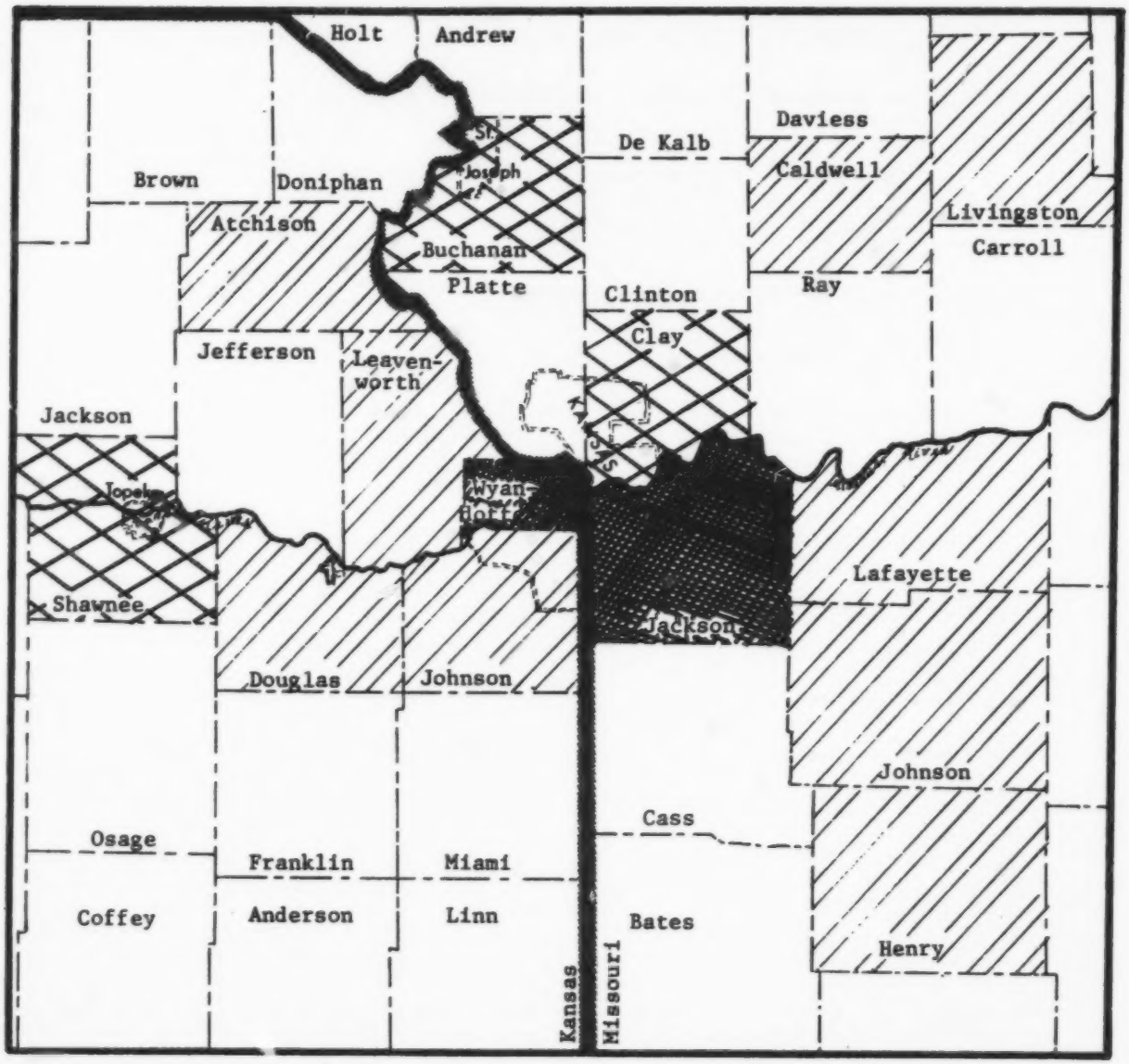
Figure 18. Industrial Land Use [3,10]

metropolitan area, Buchanan and Shawnee Counties have manufacturing employment densities of greater than ten employees per square mile. Figure 19 shows manufacturing employment density.

AIR POLLUTION PROGRAMS

In the State of Missouri, primary responsibliity for air pollution control rests with the Missouri Air Conservation Commission. The Commission has the power to adopt rules and regulations, hold hearings, enter orders and represent the State in negotiations of interstate compacts. The Commission is provided for in the Missouri Air Conservation Law, Revised 1967, where provision is also made for an executive secretary, judicial review, enforcement by penalties and injunctions, and for local and regional air pollution control programs. After review of past performance and present enforcement capabilities, the Commission may issue a certificate of exemption to a local agency when the agency adopts regulations at least as stringent as those set by the Commission. Certificates of exemption have been issued to St. Louis County and St. Louis City. Applications for such exemptions are now pending for two cities in the Kansas City area--Kansas City, Missouri, and Independence; under Missouri law, these cities may continue to enforce their ordinances while the applications are pending.

In Kansas, control authority is vested with the Kansas Air Quality Conservation Commission under the State of Kansas Air Quality Control Act of 1967. The powers and authority of the Commission are similar to those of its Missouri counterpart. Commission approved local air quality control agencies have the authority to enforce the regulations set forth by the Commission and may establish additional rules. The Kansas City,



Scale-miles

0 5 10 20 30 40

State Boundary

County Boundary

City Boundary

Figure 19. Manufacturing Employment Density (1963) [11]

Manufacturing Employees per square mile

> 100

10 — 100

1 — 10

< 1

Kansas--Wyandotte County Health Department has promulgated rules and standards for the city-county area.

Table 4 shows the annual budget levels of the five programs serving the Kansas City Metropolitan Area.

Table 4. Annual Operating Budget Levels of Air Pollution Control Agencies in the Kansas City Area.

Agency	Approximate Annual Budget
Missouri Air Conservation Commission	about $300,000
Kansas City, Mo. Health Department	about $130,000
City of Independence Health Dept.	about $ 20,000
Kansas Air Quality Conservation Comm.	about $ 95,000
Kansas City--Wyandotte Co. Health Dept.	about $ 83,000

Hearings have been held and a set of comprehensive air quality standards have been passed for the Missouri side of the Kansas City Metropolitan area for the control of incinerators, visible emissions and equivalent opacity, odors, and open burning. The Kansas City Metropolitan area as defined under the proposed regulations includes Jackson, Platte, Clay, Cass, and Ray Counties. The inclusion of Ray County in the Metropolitan Area was requested by the county court of Ray County.

A step towards interstate cooperation has been made by the formation of the Greater Kansas City Air Conservation Committee. Thirteen members make up the perm nent committee. Jurisdictions represented are as follows: The State of Missouri; the State of Kansas; Cass County; Clay County; Jackson County; Platte County; Johnson County (Kansas); Leavenworth City-County; Kansas City, Kansas--Wyandotte County; Kansas City, Missouri; North Kansas City; the City of Independence; and Sugar

Creek. The Kansas City, Missouri, Health Department, the Kansas City, Kansas--Wyandotte County Health Department, and the city of Independence Health Department operate a joint air pollution control laboratory (located at the Kansas City, Missouri, water works) which serves the seven county metropolitan area. The function of the Air Conservation Committee is to coordinate technical activities in the bi-state area (including financing the laboratory) and to serve as a forum for the sharing of information regarding common problems.

REGIONAL AGENCIES

Regional planning in the Kansas City area is handled primarily by the Kansas City Metropolitan Planning Commission. The seven-county organization includes the counties of Leavenworth, Wyandotte, and Johnson in Kansas, and Platte, Clay, Jackson, and Cass in Missouri. The activities of the Commission are numerous and include transportation, sewer and water, and land use planning, and population analysis. The Mid-America Council of Governments, which covers the same seven-county area, is a voluntary association of elected officials representing the towns, cities, and counties in the metropolitan area. Ten members of the Council serve on the Planning Commission.

There is a possibility of additional counties being added to the Metropolitan Planning Commission in the near future. In Missouri, Ray County is not presently associated with any region, but action on its inclusion in the Metropolitan Planning Commission is now pending. In Kansas, the Department of Economic Development has divided the State into regions and sub-regions for planning and development purposes. Douglas County has been included in the sub-region which contains Leavenworth, Johnson, and Wyandotte Counties.

THE PROPOSED REGION

Subject to the scheduled consultation, the Secretary, Department of Health, Education, and Welfare, proposes to designate an air quality control region for the Kansas City area, consisting of the following jurisdictions:

In the State of Kansas:	In the State of Missouri:
Douglas County	Cass County
Johnson County	Clay County
Leavenworth County	Jackson County
Wyandotte County	Platte County
	Ray County

As so proposed, the Metropolitan Kansas City Interstate Air Quality Control Region would consist of the territorial area encompassed by the outermost boundaries of the proposed counties. The proposed region is illustrated in Figure 20. Figure 21 locates the region in relation to the rest of Kansas, Missouri, and the surrounding states.

DISCUSSION OF PROPOSAL

To be successful, an air qualtiy control region should meet three basic conditions. First, its boundaries should encompass most pollution sources as well as most people and property affected by those sources. Second, the boundaries should encompass those locations where industrial and residential development will create significant air pollution problems in the future. Third, the boundaries should be chosen in a way which is compatible with and even fosters unified and cooperative governmental administration of the air resources throughout the region. The "Evaluation of Engineering Factors" (discussion beginning with Page 13) discussed the first of

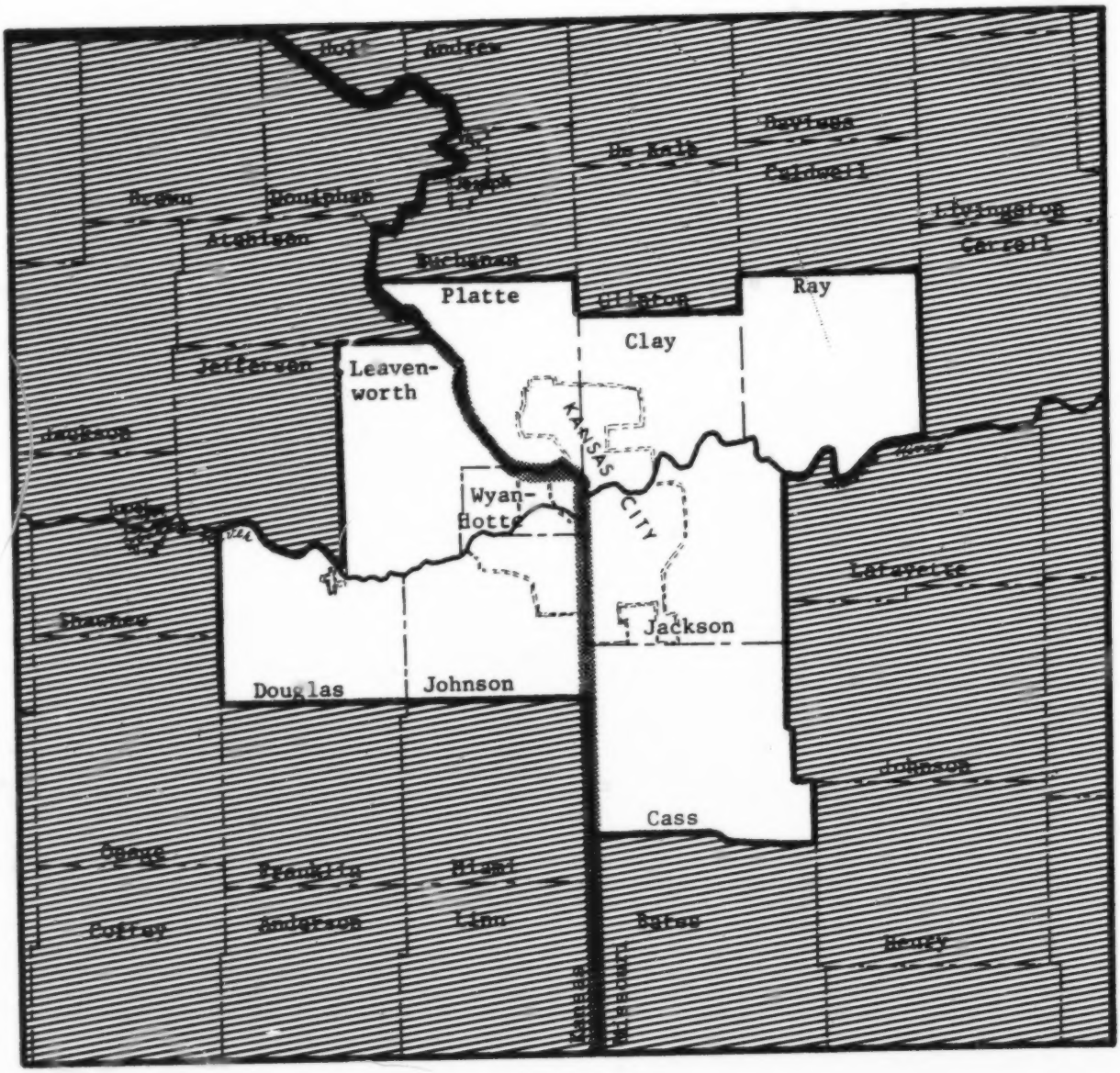


Figure 20 . Proposed Metropolitan Kansas City Interstate Air Quality Control Region.

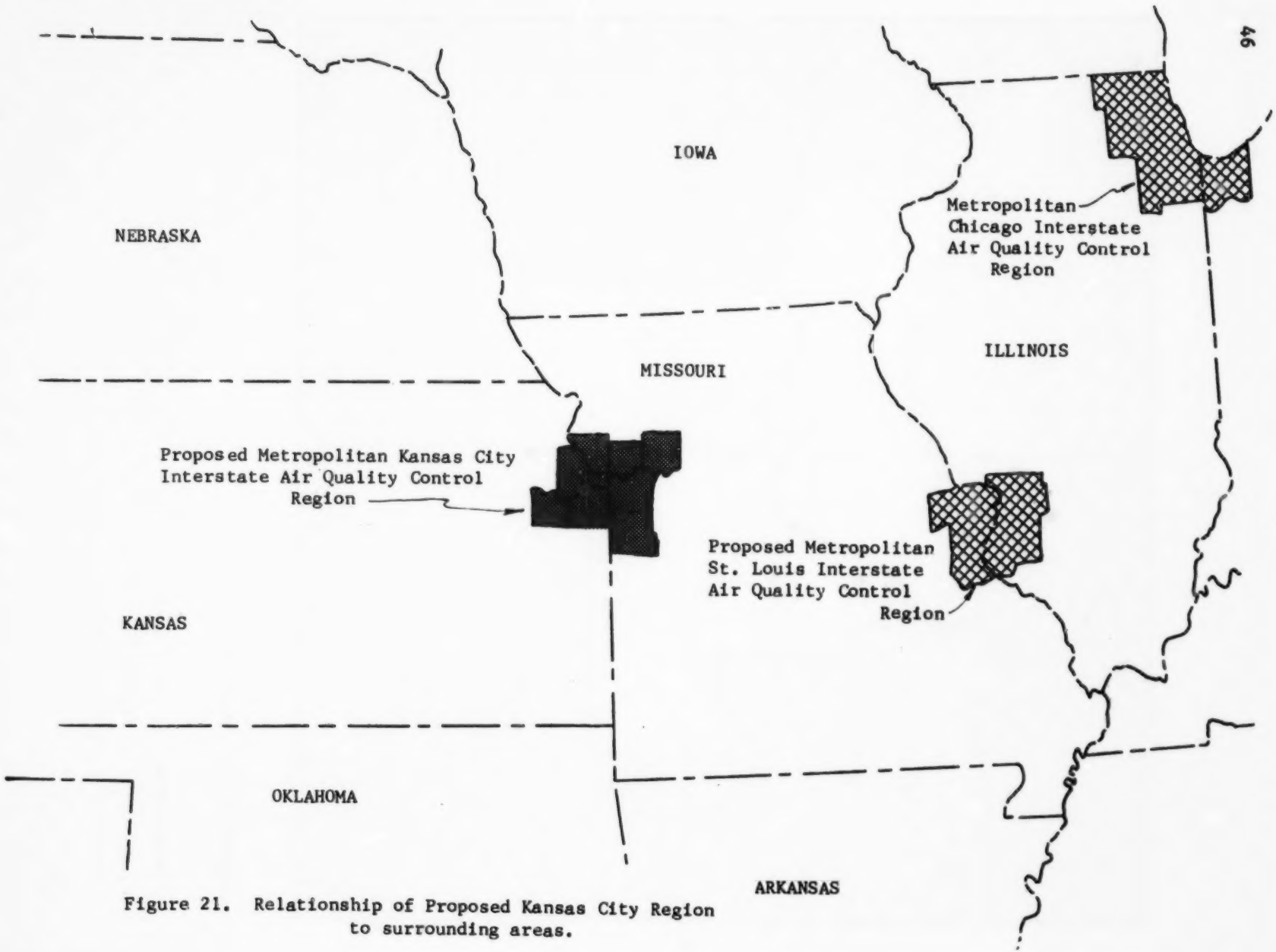


Figure 21. Relationship of Proposed Kansas City Region to surrounding areas.

these conditions, and the "Evaluation of Urban Factors" (Page 31), the second and third.

The first objective--that most air pollution sources and receptors be within region boundaries--is satisfied by the nine-county Region. The analysis of engineering factors indicates that sources from five counties (Clay, Jackson, Platte, Johnson, and Wyandotte) are the main contributors of air pollutants in the area. Parts of these counties are also affected by above-background levels (40 $\mu g/m^3$) of suspended particulates. Concentrations of 0.01 ppm SO_x and greater, though covering a smaller area, affect the same five counties. Carbon monoxide emissions are more wide-spread since the automobile is the primary contributor of this pollutant.

The diffusion model does not directly account for topography. Not shown, therefore, on the contour maps is the probable channelling of air pollution up and down the river valleys of the Kansas and Missouri. Depending upon meteorological conditions, the outlying counties of Douglas, Leavenworth, and Ray, could contribute to or be affected by the inner core area. The inclusion of these counties is not required at the present time from an engineering standpoint. However, in order to provide a buffer zone for the future, they should be included in the Region.

The second objective is directed towards future population and industrial expansion. The core of the Kansas City metropolitan area is expanding outward, and in the next two decades substantial population growth will be experienced in the outer growth rings (page 38). Douglas County has surpassed the population projections of the State of Kansas

Department of Economic Development and in the next two decades will probably experience the pressure of Kansas City metropolitan area expansion.

The third objective relates to governmental administration in the area. At present, metropolitan planning is handled by the Kansas City Metropolitan Planning Commission which covers the seven counties of Leavenworth, Johnson, and Wyandotte in Kansas, and Platte, Clay, Jackson, and Cass in Missouri. The Mid-America Council of Governments represents the same jurisdictions. Ray County's inclusion in these groups is anticipated in the very near future. Douglas County has not yet decided to join, but it is expected that Douglas will eventually join the Planning Commission and Council of Governments since it is aligned with Leavenworth, Johnson, and Wyandotte Counties as a sub-region designed by the Kansas Department of Economic Development.

As is true of most efforts to draw boundaries around an area to differentiate it from its surroundings, there is always a likelihood of bounuary conditions existing or developing. In the case of air quality control regions, such a boundary condition would exist where sources of pollution on one side of the region boundary affect in some real way air qualtiy on the other side of the boundary. Relocating the boundary would only rarely provide relief from this condition. The solution is to be found in the way in which control efforts are implemented following the designation of an air quality control region. Consonant with the basic objective of providing desirable air quality within the problem area being designated as an air quality control region, the implementation plan that follows the designation should

have provisions for the control of sources located close to but beyond the region boundaries. The level of control for such sources should be a function of, among other factors, the degree to which emissions from sources cause air quality levels to exceed the standards chosen for application within the Air Quality Control Region.

In summary, the Region proposed is considered on the whole to be the most cohesive and yet inclusive area within which an effective regional effort can be mounted to prevent and control air pollution in the Kansas City area.

REFERENCES

1. "General Atmospheric Diffusion Model for Estimating the Effects on Air Quality of One or More Sources," Martin, D. and Tikvart, J., Paper No. 68-148, 61st Annual Meeting, APCA, St. Paul, Minnesota, June, 1968.

2. "Rapid Survey Technique for Estimating Community Air Pollution Emissions," PHS Publication No. 999-AP-29, Environmental Health Series, USDHEW, NCAPC, Cincinnati, Ohio, October, 1966.

3. "Kansas City, Kansas-Kansas City, Missouri Air Pollution Abatement Activity, Phase II, Pre-Conference Investigations," USDHEW, Public Health Service, March, 1968.

4. ibid., pages 108 and 109.

5. "Estimates and Projections--1969" (Population, Housing, Employment, Retail Sales, Income), Kansas City Metropolitan Region, February, 1969, Metropolitan Planning Commission/Kansas City Region.

6. "Projections of Socioeconomic Data to 1967, 1975, and 1990, Summary Report", Missouri State Highway Department, Division of Highway Planning, June, 1968.

7. "Population Projections--Kansas City Metropolitan Region", Metropolitan Planning Commission/Kansas City Region, P-3 April 1968.

8. "The Future Population", Table 14--Population Forecast, Topeka Metropolitan Area, 1965, 1970, 1975, 1980, Topeka-Shawnee County Metropolitan Planning Agencies.

9. "Population Projections for the State of Kansas by Counties for the Years of 1980, 2000, and 2020", State of Kansas Department of Economic Development.

10. "Metropolitan Kansas City Industrial Map", Chamber of Commerce of Greater Kansas Ctiy.

11. Commercial Atlas and Marketing Guide, Ninety-ninth edition, 1968, Rand McNally and Company.